DOCUMENT RESUME

ED 050 905 RE 003 570

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TITLE	The Effects of Specific Directions on the Reading Comprehension of Sixth-Grade Students.
SPONS AGENCY	Rutgers, The State Univ., New Brunswick, N.J. Graduate School of Education.
PUB DATE	Jun 71
NOTE	153p.; Thesis submitted partial fulfillment of the requirements for the degree of Master of Education
EDRS PRICE	EDRS Price MF-$0.65 HC-$6.58
DESCRIPTORS	*Directed Reading Activity, *Grade 6, Informal Reading Inventory, *Learning Processes, Reading Achievement, *Reading Comprehension, *Reading Research, Reading Tests

ABSTRACT

The effects of specific directions on the reading comprehension of sixth-grade students were investigated. Two passages on different topics, each with 20 percent of the sentences relevant to the topic, were materials for two informal tests administered to 92 six-grade students. Half of the students were given specific directions to learn about the relevant topic, and the other half were not. The post-test contained questions on the relevant and incidental materials. A Focus Ability test and the Gates-MacGinitie comprehension subtest followed. Findings showed that (1) the results from the two material sections were in conflict, (2) the ability to identify relevant material in a passage was not related to the ability to learn the relevant material selectively, (3) there was a low positive relationship between the ability to identify relevant material and the standardized measure of reading comprehension, and (4) the informal measure of reading comprehension scores were significantly correlated with the standardized measure of reading comprehension scores. Further research was suggested. Tables, appendixes, and a bibliography are included. (AW)

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THE EFFECTS OF SPECIFIC DIRECTIONS ON THE READING COMPREHENSION OF SIXTH-GRADE STUDENTS

A THESIS

SUBMITTED TO THE FACULTY

OF THE GRADUATE SCHOOL OF EDUCATION

OF

RUTGERS UNIVERSITY

THE STATE UNIVERSITY OF NEW JERSEY

BY

DIANA HEYWOOD CALBY

IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE

OF

MASTER OF EDUCATION

NEW BRUNSWICK, NEW JERSEY JUNE, 1971

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RE 003 570

ABSTRACT

The purpose of the investigation was to study the effects of specific directions on the reading comprehension of sixth-grade students. The underlying question was, "Can directions control the reading behavior of the students?" The relationships between reading achievement, ability to identify relevant material in the passage, and the effects of the directions were also explored.

Two 1,000-word passages written on the sixth-grade reading level were prepared by the investigator. The passages were similar in construction but were written about two different topics--Auguste Piccard and the Eddystone lighthouse. Twenty percent of the sentences in each passage were relevant to the topic while the other 80 percent were not directly related or were incidental to the topic.

Two informal tests which utilized these two passages and the comprehension section of a standardized reading survey were administered to 92 sixth-grade students. In the first test, half of the students were given specific directions to read the assigned passage carefully and to learn about the relevant topic. The other half of the students were given general directions to read the assigned passage and to learn as much as they could. The students were given a posttest which contained questions on the relevant and incidental material. The number of

correct relevant answers and the total number of correct answers on the posttests were tabulated.

Second, the students were given a Focus Ability test which measured the ability to identify relevant material in a passage and to disregard incidental material. The students were directed to read a second and different passage carefully and to underline the sentences which were relevant to the topic. The Focus Ability score for each student was the number of sentences underlined correctly less a correction factor for guessing.

Third, the students were given the Comprehension subtest of the Gates-MacGinitie Reading Tests, Survey D, Form 1. The standard scores for each student were determined.

The means of the relevant questions answered correctly in the specific and general direction groups were compared for both material sections. The purpose was to determine if the students answered more relevant questions correctly under specific directions than under general directions. The Piccard section had more correct relevant answers in the specific directions group than in the general directions group. The Eddystone sections had just the opposite. Correlation coefficients were determined between the test results which related to the purpose of the study.

There were four main conclusions based on the findings of this investigation.

1. The control of reading behavior, as indicated by the number of correct answers on the posttests, was not attained in this study. The results from the two material sections were in conflict.

2. The ability to identify relevant material in a passage (Focus Ability scores) was not related to the ability to learn the relevant material selectively as indicated by the number of correct relevant answers on the posttests of the specific group.

3. There was a low positive relationship (r = .34, p < .01) between the ability to identify relevant material and the standardized measure of reading comprehension (Gates standard scores).

4. The informal measure of reading comprehension (total number of correct answers on the posttests) were significantly correlated (r = .78, .61, .81, .50, p < .01) with the standardized measure of reading comprehension.

ACKNOWLEDGMENTS

Appreciation is expressed to the members of the thesis committee: E. B. Fry, L. H. Mountain, and D. L. Cox.

The cooperation of Dr. Robert Hiltenbrand, Director of Instruction of the West Windsor-Plainsboro Regional Schools, and the sixth-grade teachers of the Dutch Neck School is gratefully acknowledged.

Gratitude is also expressed to Mr. Robert Jacobson, Chief Engineer, Agricultural Division, American Cyanamid Company, Princeton, New Jersey, for his advice and assistance with the treatment of the data.

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CHAPTER I

THE PROBLEM

One of the major objectives of reading is learning from written material, or reading comprehension. Directions, questions, and stated purposes are widely used to help achieve this objective. Research in the field of reading is necessary to make these aides as effective as possible.

Purpose of the Study

The basic purpose of this investigation is to learn more about the usefulness of directions. The experiment is designed to study the effects of specific directions given before reading on the reading comprehension of sixth-grade students. The extent of the influence of the directions will be inferred from posttest results.

In addition, the study is designed to explore the relationships between the student's reading achievement, his ability to identify relevant material in a passage, and the effects of the directions.

The definition of reading comprehension stated by Bormuth (1969) is the one used in this investigation. He said that the term comprehension "refers to an increase in

the amount of information an individual is able to exhibit as a consequence of reading a passage of verbal material [p. 50]." The terms reading comprehension and learning from written material are synonomous in this thesis.

The references cited in this investigation are from the fields of reading and verbal learning. In particular, the concept concerning learning from written materials described by Rothkopf (1963, 1965, 1970) will be used in discussing the results. The underlying question of the experiment is, "Can directions control the reading behavior of the students?"

Statement of the Problem

1. Which group learns more relevant material based on posttest scores:

   a. Students who are given specific directions about what to learn?

   or

   b. Students who are given general directions to learn as much as they can?

2. Is there a relationship between the sixth-grade students':

   a. Focus Ability scores and number of relevant questions answered correctly?

   b. Focus Ability scores and the total number of correct answers on the posttests?

c. Focus Ability scores and Gates standard scores?

d. Gates standard scores and total number of correct answers on the posttests?

Definition of Terms

Relevant material refers to 12 sentences on a particular topic which are part of a 60-sentence passage prepared for this experiment. The number of relevant questions answered correctly on the posttest is a measure of relevant learning.

Incidental material refers to the 48 sentences in the 60-sentence passage which do not relate to the relevant material. The number of incidental questions answered correctly on the posttest is a measure of incidental learning.

Specific directions direct the students to read the passage carefully and learn about the relevant topic.

General directions direct the students to read the passage carefully and learn all they can.

Focus Ability score is the number of relevant sentences underlined correctly less one-fourth the number of incidental sentences underlined incorrectly to correct for guessing. Focus ability is the measure of the ability to identify relevant material in a passage and to disregard the incidental material.

Reading achievement refers to the standard scores on the Comprehension subtest of the Gates-MacGinitie Reading Tests, Survey D, Form 1.

Implications of the Study

Studies of this kind can contribute to a fuller understanding of the effects of directions on reading comprehension.

Information on the effects of specific and general directions may assist teachers to use directions in a more precise fashion. This precision might help students accomplish the educational objectives of the situation in an effective and efficient manner.

More knowledge about the use of directions and their effects should be helpful in the design of new types of self-instructional curriculum materials. For example, a text could be prepared with accompanying specific instructions on its use. The instructions and text combined could assist the reader to accomplish the educational goal. Self-instructional units of this type may have special application in individualized programs.

Limitations of the Study

The sample for this study was comprised of sixth-grade students from one school in a middle-class community.

The students had received most of their reading instruction from a basal reading program and their reading achievement was above average. The findings may not be applicable to students of differing abilities, grade levels, social characteristics, or previous training.

Another limitation concerns the nature of the test materials prepared by the investigator. The instruments were informal, and the findings must be interpreted on this basis. Also, the investigator did all the testing.

The reading passages used in the investigation pose another limitation. Although the passages resembled narrative social studies prose, they were carefully controlled with regard to style and organization. This was necessary because the passages were used as experimental materials.

Overview of the Study

The investigator prepared two passages on different topics, one on Auguste Piccard and one on the Eddystone lighthouse. Each had 12 sentences which were relevant to the topic. These relevant sentences were embedded in 48 sentences which were not directly related or were incidental to the topic.

Three tests were administered to the 92 sixth-grade students. A stratified randomization procedure was used to assign the four classes to direction groups and

the students in each class to either the Piccard or Eddystone passage. Half the students were given specific directions and half were given general directions prior to reading the assigned passage. Both groups were told to expect a posttest. The tests contained questions on both relevant and incidental material. The posttest performance was used as a measure of the amount learned from these written materials.

The students were given a Focus Ability test which measured the ability to identify relevant material in a passage and to disregard incidental material. The students were directed to read a second and different passage carefully to underline the sentences which were relevant to the topic.

After the informal tests all the students were given the Comprehension subtest of the Gates-MacGinitie Reading Tests, Survey D, Form 1. The standard scores were considered to be a measure of the students' reading achievement.

The means of the number of relevant, incidental, and total answers correct on the posttest of each section were calculated. Comparisons between the means were made. The mean Focus Ability scores and mean Gates standard scores for each section were determined. The results on the tests were correlated using standard statistical

procedures. Conclusions were drawn based on the questions posed.

CHAPTER II

REVIEW OF THE LITERATURE

This survey of the literature cites studies which are concerned with reading comprehension and the control of reading behavior. It is divided into four main sections, each of which may have a number of subsections. The first section includes studies on the effects of prequestions and stated purposes on reading comprehension. The second section centers around the concept of mathemagenic behavior, a way to consider reading comprehension. A third section includes other research, particularly pertinent to this study. The fourth section is a summary of the main ideas of the other sections.

Use of Questions and Purposes to Affect Reading Comprehension

The effects of prequestions and purposes on reading comprehension have been studied by several investigators. Table 1 includes a summary of the methods used to affect comprehension in each study. The table also indicates whether the method used had a positive effect, a negative effect, or no effect on comprehension.

These investigators used a test given after

TABLE 1

SUMMARY OF STUDIES ON THE EFFECTS OF PREQUESTIONS AND PURPOSES ON READING COMPREHENSION

Investigator	Pre-questions	Purposes	Effect on reading comprehension: Positive	Negative	None
Distad (1927)	x		x		
Ballard (1966)	x		x		
Fincke (1968)	x		x		
Holmes (1931)	x		x		
Peeck (1970)	x		x		
Bloomer and Heitzman (1965)	x			x	
Goudey (1970)	x			x	
Smith (1967)		x			x
Torrance and Harmon (1961)	x	x	x		
Henderson (1965)	x		x		

reading to measure comprehension. They compared the test results for groups with prereading activities to those with no prereading activities.

Prequestions. Several investigators reported that prequestions affected reading comprehension favorably.

Distad (1927) compared the effects on reading comprehension of (1) reading to find the answer to assigned specific questions, (2) reading when pupils were given a general problem to solve, (3) reading to find the answer to questions which were raised in a group discussion, and (4) undirected reading. He found that the immediate recall of the groups reading with specific questions, with a problem, and with raised questions exceeded the recall of the undirected reading group in most of the comparisons made. Distad found a tendency for the raised questions and problem groups to exceed the performance of the specific questions group.

Ballard (1966) reported an investigation which studied the effects on comprehension of (1) guiding questions, (2) motivating questions, and (3) no questions before reading. He found that the guiding questions were best for fourth- and fifth-grade students for understanding both the material relevant to the questions and the whole selection. Motivating questions were no better than reading without questions. The guiding questions were

equally effective for students of all reading achievement levels.

Fincke (1968) described a study in which he used a different experimental design. He compared the results of two comprehension tests of individual third-grade students. One test followed reading with no prequestions and one test followed reading where prequestions were used. Fincke reported the effects of factual and emotionally appealing questions. He found that reading with factual prequestions resulted in significantly higher comprehension scores. He also found that emotionally appealing prequestions did not affect reading comprehension.

Two investigators, Holmes (1931) and Peeck (1970), described research which is particularly relevant to this study. They both reported results of two kinds of comprehension scores--comprehension of material related to the questions and comprehension of the other material in the passage.

Holmes (1931) investigated the effects of guiding or study questions on reading comprehension. The question groups in the experiment progressed in three steps: (1) read a study question on a main point; (2) then, read to find the answer; (3) then, read another question; and so on. The control group read and reread rapidly. She compared the comprehension test results of the two kinds of

groups. All posttests contained the same study questions and an equal number of new questions on the support material.

On the immediate posttests Holmes found that the question groups had significantly higher scores on study questions than the rereading groups. The rereading groups had similar scores on both types of questions on their posttests. In some cases they had higher scores on the new material than the question groups. In summary, the rereading groups had somewhat less total learning and a different balance between the two kinds of learning when compared with the question groups.

On the delayed posttest the question groups performed significantly better on the study questions than the rereading groups. The question groups had no apparent depression on the new questions. Holmes concluded from this experiment that guiding questions were superior to rapid reading and rereading. Unfortunately, the results on the delayed test were confounded with the difficulties of comparing retention of main ideas and supporting details.

Peeck (1970) reported a study concerning the effects of a set of prequestions on immediate and delayed retention test scores. He compared the results of the tests of prequestion groups with those of reading-only

control groups. One reading control group had extended reading time. The extra time was equal to the time given to the prequestion groups to deal with the questions. The other reading control group had the same amount of time to read as the prequestion groups.

On the delayed retention test he found that the prequestion groups learned significantly more question-related material than the reading-only control group. However, they retained significantly less of the other content of the passage than the extended reading time control group. The extended time group had about the same total test scores as the prequestion groups.

Peeck made the following statement:

> Hence, it seems that time spent on prequestions instead of on reading the article did not affect the total amount of knowledge acquired while it did affect the selection of contents learned, that is, the distribution of knowledge [p. 244].

He concluded that prequestions were useful when the objective was retention of specific material. When the objective was more balanced learning he suggested that the use of prequestions did not seem advisable.

Negative effects of prequestions on reading comprehension were reported by Bloomer and Heitzman (1965) and Goudey (1970).

Bloomer and Heitzman (1965) described a study on the effects of pretesting before reading on posttest

scores. A McCall Crabb test lesson was used as the reading text. They used the same sets of questions on the pretest as on the posttest. The eighth-grade students with no pretest had significantly higher scores on the posttest than the students who had a pretest.

Goudey (1970) compared the total posttest scores of prequestion groups and reading control groups. When prequestions were used to guide the reading for information, he found that the reading control groups which had no prequestions did significantly better on the posttest than the question groups. When the prequestions were used to guide reading for appreciation, he found no significant differences between the groups. He was cautious in his conclusion but he did state that directed reading as commonly stressed may not be as useful as believed.

Purposes. Some researchers have investigated the effects of setting a purpose for reading. The purpose for reading may be stated in various forms, such as directions, questions, or problems to solve.

Smith (1967) suggested that purpose influences the reader's mental set and determines what the reader intends to get from a selection. In this study the purpose was based on instructional objectives set by the examiner. Smith directed good and poor high school readers to read a selection for details and for general impressions. She

studied the students' responses to questions on general impressions and details after reading for each purpose.

Smith found that the directions had no differential effects. There were no significant differences between the mean percent correct responses on detail and general questions when the good readers read for either of the two purposes. The same was true for the poor readers. The readers did show that they knew the difference between the two because they answered the detail questions with details and general impression questions with general information from the passage.

Torrance and Harmon (1961) assigned three different approaches or reading sets to graduate students to use on reading their assignments. The reading sets were memory or literal comprehension, evaluating or critical reading, and creative thinking or appreciation. Torrance and Harmon suggested that the assigned sets functioned like those caused by purposes stated before reading. The students were tested with comprehension questions compatible with the assigned set and the other sets. The investigators found that the students apparently maintained their reading sets for only half of their reading time. However, there still were measurable effects upon the goals achieved, or the reading comprehension, especially for the creative thinking group.

Henderson (1965) was interested in individual purpose setting. He compared the performance of three fifth-grade groups. In the first group the student set the purpose, in the second group the examiner set the purpose, and in the third group no purpose was set before reading. Henderson concluded that good readers were more effective in setting purposes than poor readers. He also found that the students who set purposes well attained them well when the examiner set the purpose.

Reading control groups. The kinds of directions given to the reading control group may affect their comprehension test scores. These scores might cloud the results of an experiment.

Rothkopf (1968) investigated the effects of rereading of a passage upon the score of a comprehension test. He found that learning increased for the first two readings and leveled off and decreased slightly for continued rereading. He generalized by saying that repeated rereading would result in reduced learning.

Characteristics of the reading passage. A recent study by Bruning (1970) illustrates how the characteristics of the passage used in an experiment may affect the results of the research.

Bruning constructed three controlled prose passages. In the first, he placed a general topic or

superordinate sentence at the beginning of each paragraph. This was followed by three subordinate sentences related to the topic sentence. In the second, he placed all the sentences in random order. In the third, he interspersed the several subordinate sentences which were to be tested on the posttest in an irrelevant context (material which was not related to the sentences).

The posttest scores showed that the group which read the sentences in the irrelevant context learned significantly less than the other groups. The order of presentation of the sentences in the relevant contexts had no significant effect on the scores.

Bruning suggested that multiple input may facilitate learning. That is, when the context supplies more information, a fact may be retained more easily.

Mathemagenic Activities

Rothkopf (1963, 1965, 1970) described an interesting concept concerning learning from written material. The basic premise of this concept is that what is learned from written material is dependent on the behavior of the reader. He suggested that this behavior framework provided a convenient way to think about learning or reading comprehension. His conceptualization was useful to the investigator in explaining the results of this study.

Definition. Rothkopf (1963) coined the word

mathemagenic. It is based on two Greek roots, mathemain which means "that which is learned" and gignesthai which means "to give birth."

Rothkopf (1970) defined mathemagenic behavior as "those activities that are relevant to the achievement of specific instructional objectives in specific situations or places [p. 328]."

Background on the concept of mathemagenic behavior. Some information on learning from self-instructional programs and from incidental learning is necessary to understand the concept of mathemagenic behavior.

Since Skinner (1957, 1958) presented his ideas on verbal learning and self-instructional programs, the function of responding in each frame has been the subject of research. Skinner suggested two ideas: first, the student "compose" or write response to the blank in the frame and, two, that upon verification, the knowledge that this response is correct is the reinforcing stimulus.

Holland (1960) postulated that completing the items "serves only to control the behavior of observing the data [p. 223]."

Alter and Silverman (1962) reported three experiments which gave evidence that constructing the response and receiving knowledge of results might not be the determining factors in learning from written programs. They

compared the reading of a self-instructional program which was cast into statements with either overt or covert responding. Alter and Silverman concluded that their evidence pointed to the importance of the frame and not to the construction of the response.

A study by Levine, Leitenber, and Richter (1964) suggested that knowledge of results was not necessary for learning. They reported a series of experiments which showed that subjects behaved the same way when given no outcome or a blank after a response as when the examiner said right after a response.

Two salient points on incidental learning which were stated by Postman (1964) are important. First, intentional and incidental learning define the extremes of a dimension; that is, the two kinds of learning appear to be governed by the same principles. Second, the instructional stimulus influences what is learned by determining which cues elicit the responses which cause learning. The instructional stimulus causes the differences between the two.

Concept of mathemagenic behavior. Rothkopf (1963) formulated a conceptual model for learning from written materials based on an analysis of learning from programmed materials. He called his concept mathemagenic behavior. His conjectures concerned the discrimination between the

response requirement, blank to fill, and the mediating behavior which took place while filling the blank. He considered the nature of the mediating behavior which he termed inspection behavior, and its effect on learning, that is, whether the training objectives were accomplished or not.

Rothkopf (1965) discussed his conceptual model of learning and the important relationship between nominal stimulus and effective stimulus (functional stimulus). Nominal stimulus can be specified by some physical measurement. Effective stimulus is the psychological consequence of stimulation and cannot be directly observed but only inferred, usually by retention tests. The activities of the subject when confronted with an instructional document determine the character of the effective stimulation and govern what is learned.

Rothkopf extended his use of the term mathemagenic to include behaviors that produce learning such as posture, eye movement, and inferred activities such as inspection. He indicated that mathemagenic behavior can be functionally classified and that each class has attributes that can be modified by external events. That is, just as the response requirement in a self-instructional program frame has stimulus control over learning behavior, so environmental events such as directions can control mathemagenic

behavior.

Rothkopf (1970) suggested that the student's own mathemagenic activities were the most important factor in what he learned from written material, although content and organization of the materials were factors also. He stated that attention, set, and cognition were some of the variety of names used to allude to these activities.

Rothkopf defined four classes of behavior:

Class I--orientation and proximity to the material;

Class II--selecting the appropriate instructional materials;

Class III--primary translation activities, scanning, and systematic eye fixations;

Class IV--multilevel process of reading.

The first three are directly observable and the fourth is generally inferred indirectly from retention tests.

Rothkopf further classified reading into three classes of actions: (1) translation, internal consequences of Class III activities which can be partly indexed by them; (2) segmentation, which establishes linkage among terms and is allied to intonation and inflection in oral reading; and (3) processing. They are progressively independent of direct stimulus control, and are progressively "deeper." All have memorial consequences. He cited studies which suggested that mathemagenic activities are

adaptive and the behaviors have respondent and operant characteristics.

Rothkopf discussed the modification of Class IV activities by directions of intent, by manipulative directions, and by adjunct questions. He stated that the activities may be positive and facilitate performance on the criterion test or may be negative and depress the performance level.

Rothkopf also pointed out that the characteristics of mathemagenic activities must be discovered and classified for each instructional situation. That is, some activities are appropriate for learning from a short written passage which is read independently and others are appropriate for learning from a motion picture viewed with a group.

Use of self-test questions to control reading behavior. Pressey (1960), in his research on self-tests and self-scoring with punchboards, found that gains in learning were substantial when self-tests were used systematically as adjuncts to the course instruction.

Rothkopf and Coke (1963, 1966) reported experiments on repetition interval and rehearsal method in learning. They found evidence of inspection behaviors which were not consistent with the training objectives. Their data showed that a long series of anticipation

trials, fill-in-the-blank sentences, or self-test items have a negative effect on inspection behavior. An occasional anticipation trial in the midst of simultaneous presentation trials or reading has a positive effect on inspection behaviors. They also established that controlled prose could be used to investigate verbal learning problems.

Hershberger (1964) reported a study on self-testing and typographical cueing in history and science materials. Elementary students were the subjects. As part of his experiment he placed several self-test questions at regular intervals in the written text material. The scores on the posttest showed that the subjects who used self-test questions approximately doubled the amount learned about the materials related to the questions. They also made slight gains in the other material in the passage as compared with scores of those who did not use self-test materials.

Similar studies reported by Hershberger and Terry (1965a, 1965b) confirmed the previous finding by Hershberger that self-testing as an adjunct program or a linear-type program added to the written material.

Rothkopf (1966) reported the results of a key investigation on the effects of self-test questions on learning from written material. The self-test questions

were inserted into the reading passage either before or after the sections which related to the questions. He found that self-test questions placed in a passage can affect not only the learning of the material related to the questions, but also the learning of other material in the passage. When the questions were placed after the section relevant to the questions, the posttest scores on both kinds of material increased. When the questions were placed before the relevant section, only the posttest scores on the material related to the question increased. He found that the subjects who were given directions to read carefully learned somewhat more than the cursory reading control group. He suggested that self-administered test questions following each section of text material and the directions to read with care were environmental controls of learning behavior (mathemagenic behavior).

Using different college subjects and different material, Frase (1967) had the same finding as Rothkopf (1966). He stated that "the rank-order correlation of the means of the two studies is significant at the .01 level, attesting to the generality of Rothkopf's finding [p. 269]."

Frase found that the knowledge of results, whether or not answers were given with the self-test questions,

interacted significantly with the position of the questions, whether they were placed before or after the section. One particularly interesting finding concerned the effects of prequestions with no answers supplied immediately. When these questions were placed before the section, they tended to depress relevant and incidental learning below that of a reading-only control group. He postulated that this was caused by limiting the range of attentive behavior.

A study by Bruning (1968) using college students substantiated the results of Rothkopf (1966) and Frase (1967). Bruning concluded that the use of self-test questions may be an important "environmental control" of learning behavior.

Variables which affect the control of the questions. Three studies illustrate the effects of different types of questions on learning from written material. Two of them indicate some tendency for the questions to shape behavior.

In a series of experiments Keislar (1960) directed students to read a series of twenty-two paragraphs which were followed consistently with a certain type of question with the knowledge of results. After paragraph twenty-three they were asked the same type of question, and a different type. They did significantly better on the

type of questions on which they had been tested before. Keislar concluded that the students' learning sets had been shaped by the consistent use of one kind of post-question.

Rothkopf and Bisbicos (1967), using high school subjects, studied the effects of various categories of self-test questions upon the inspection behavior. The various treatments were arranged to vary the kinds of answer required: common phrase, technical phrase, measurement, proper name; and position of the questions before or after the relevant sections. The facilitating effect of postquestions on the specific and incidental learning was found substantiating earlier findings. There was some tendency for the questions which were placed after the relevant passage to shape behavior. This was shown by slightly better scores on the measurement and proper name questions drawn from the second half of the material.

Frase (1968a) reported a study on the effects of specific and general questions on reading behavior. Using especially constructed short paragraphs, Frase conducted two experiments. First, he asked a general or a specific question and directed the subjects to underline the answer in the paragraph. The subjects tended to underline both stimulus and response in answer to the specific questions,

but when faced with a general question which was associated with more words, they tended to underline response words and tended to ignore the stimulus words. In the second experiment, Frase asked one question, general or specific, directed the subjects to read the paragraph and then administered a retention test. The specific prequestion group did better on specific questions and, further, did better on the total retention test than the general prequestion group.

Frase concluded that while the general questions caused the subjects to attend to more material, they did not cause them to practice both the stimulus and the response and make the association between the two, as did the specific questions. The general questions also appeared to increase the information load or uncertainty in relationship to the questions on the retention test. Frase summarized his finding by stating that it is important to maintain stimulus control in a free responding situation such as reading. Precise control may be obtained by the use of questions or an orienting task designed to cause behavior appropriate to the objective.

Two other studies found that the frequency of the self-test questions and the incentive level of the students affect the learning of relevant and incidental material.

Frase (1968b) explored the interaction of the frequency of the self-test questions with other variables on the scores of the posttests. He replicated previous results by showing that general and specific facilitation were best when questions were placed after the paragraphs. Frequent postquestions lowered the learning of incidental material. Varying the frequency of the postquestions had a reasonably constant effect on the retention of relevant material.

Frase concluded that successful use of adjunct questions involved two processes: (1) "selective reinforcement of relevant material" or a review function, and (2) the shaping or eliciting of effective reading behavior.

Incentive also affected the control of the questions. Frase, Patrick, and Schumer (1969), using college subjects, evaluated the interaction of differing levels of incentive upon the frequency and position of questions. The students in the incentive groups were paid for correct answers. The customary control groups were used.

They discussed their results in terms of "inhibitory responses" which resulted in rejection of information, and which they suggested were an important class of mathemagenic activities. They stated that the question activated an inhibitory response potential, that is, responding

to relevant material seems to be accompanied by inhibitation of responses to incidental material. For example, as Frase (1968a) reported, prequestions inhibited incidental learning as they served as a cue to identify relevant material. The results showed that the incentive factor took over, and apparently the questions had little control, or had less inhibitory effects on incidental learning. The reading control group did as well as the pre- and postquestions groups on relevant and incidental posttest items at the high incentive level.

Use of manipulative directions and passage organization to control mathemagenic activities. Two representative studies illustrate the use of manipulative directions and material organization to control learning behavior. They are also useful in understanding the concept of external control of reading behavior.

Frase (1969) stated that he viewed the reading of an organized passage as involving several factors, including objectives, the reader's skill repertoire, and the nature of the written material. These elements interact in a complex way to produce various responses such as the use of appropriate strategies and written responses in answer to questions.

Frase explored this view in an investigation testing "cybernetic control," a theory of cognitive processing

in which the reader responds to stimuli, evaluates his response against an internalized criterion, and uses the results to select further input, all arranged in a closed loop. He hypothesized that the question, requiring the subject to search for an answer, would set the goal, be subsequently stored in memory, and serve as a criterion for selecting stimuli from the prose.

Frase designed two passages, one in which the sentences were organized by concept name and one in which the sentences were organized by attribute. The subjects were told to find the name of a concept but were not told to learn the material. He hypothesized that the more useful verbal unit (the one used in making the criterion comparisons) would be retained better as they were stored in memory. His findings verified the hypothesis. He concluded that he could control what was learned by controlling the organization of the prose and the nature of the orienting task or the question.

Frase and Silbiger (1969) investigated the use of a prequestion designed to cause the subjects to search the material for an answer. They hypothesized that a search involved discrimination and comparisons of stimuli with some criterion. The material, similar to Frase (1969), was especially organized around a name or attribute and arranged in certain orders. They found that the more

sentences that the subjects searched, the better they scored on the recognition test. They also found that when stimuli comparisons were made, both the criterion and the stimuli evaluated against it were influenced, or that simple discrimination can produce learning. They used research on incidental learning to explain the results. This finding is in contrast to Frase (1969) when he concluded that the verbal unit used as a criterion was retained better than the unit evaluated against it.

Other Pertinent Studies

Gans (1940) reported a study on critical reading of intermediate students. She compared the students' critical reading ability with measures of reading achievement. She was particularly interested in the function of critical selection and rejection of material in reference reading.

She set a purpose for reading by posing a problem such as preparing for a social studies play. The students were directed to read short selections and to indicate if they thought that the selection would help them solve the problem. She found that there was a significant shift from a specific to a general understanding of the problem after reading five paragraphs.

Gans also found that reference reading is a

composite ability which definitely has more than two factors. The most potent factor is reading ability as measured by the reading surveys. The second factor is the selection-rejection pattern of material on the basis of the problem to be solved, and the third may be some type of delayed recall, and there may be others.

Sochor (1958) investigated literal and critical reading in social studies. She reported a significant correlation ($r = .76$, $p < .05$) between literal comprehension and the Gates Reading Survey, Level of Comprehension. The literal comprehension questions used by Sochor were similar to the questions on the posttests in this study. The revision of the Gates Reading Survey is the Gates-MacGinitie Reading Tests. The Gates-MacGinitie was the test used in this investigation.

Summary

This survey described the effects of prequestions and purposes on reading comprehension. It also described and illustrated the concept of mathemagenic activities, as related to this investigation. Finally, it made reference to a few studies connected with particular aspects of this study.

These three parts of the review of literature develop the following points:

1. The research on learning from written material

has implications for the study and understanding of reading comprehension.

2. There is an overlap in the research on verbal learning, learning from written material, and reading comprehension. This overlap occurs when controlled prose passages are used to study verbal learning. This type of learning is generally called literal comprehension in the reading studies.

3. The investigations showed that reading behavior can be influenced by various external controls, such as questions and directions. The influences of these controls were inferred from results on posttests or reading comprehension tests.

4. The research on prequestions showed that certain types of prequestions did affect the comprehension of the material related to the questions in a positive way. However, prequestions may decrease the amount of learning of the material not related to the questions.

5. Under certain conditions, self-test questions placed after sections in a passage from which they were drawn facilitate learning. They may facilitate the learning of both the material related to the self-test questions and the other material in the passage.

6. The use of directions to read carefully influenced reading comprehension in a positive way.

7. There are some inconsistencies in the findings reported. They are related to such factors as (1) types of questions--specific, general, emotionally appealing, and so on; (2) type of reading control group used; (3) whether total posttest score or parts of the scores were considered when drawing conclusions; (4) style, organization and reading level of the material; (5) maturity and ability of the students.

This study proposes to investigate the effects of specific directions to learn relevant material in a passage. Further, it proposes to determine if there is any relationship between the selective learning of this relevant material and the ability to identify the relevant material in the passage.

The procedure of the experiment is similar to the reading comprehension studies cited in this review. Directions are used as the prereading activity. Reading comprehension tests (posttests) are used to assess the influence of the directions. A standardized reading survey is used as a basis for comparing the reading achivement of the groups.

The general concepts underlying mathemagenic behavior, as described in the survey, are applied to the design and execution of the investigation. Fundamental to the understanding and application of this concept is the

knowledge of the numerous factors mentioned in the survey which affect reading comprehension.

The experiment is unique to the best knowledge of the investigator since no studies were found which combined and investigated the same variables and sample.

CHAPTER III

PROCEDURES

This chapter includes an account of the procedures which were used to investigate the effects of specific and general directions on learning from written material. The content and administration of the three tests used in this experiment will be described.

The sections in this chapter describe the following: the sample, the informal test materials, the standardized reading survey, the test administration, the design of the study, and the treatment of the data. A summary is included.

Sample

The sample for the study consisted of 92 sixth-grade students in four classes in a middle-class, suburban elementary school. The classes at this school were heterogeneously mixed according to such factors as intelligence, achievement, production, and cooperation.

Description of the Informal Test Materials

The investigator prepared the informal test materials. These materials were typed and reproduced by a

photocopy process. All the test materials were coded as requested by the school.

Appendix II contains a description of the development of the test materials. Samples of the materials are included in the form in which each appeared before the first and second tryouts.

Prose passages. Two similar passages of nonfiction narrative prose written on a sixth-grade reading level were used in the study. The Fry Graph for Estimating Readability was used to estimate this level.

The first passage had 12 sentences on Auguste Piccard and the things that he did embedded in 48 sentences of incidental or general information not directly related to Piccard. The second one had 12 sentences on the Eddystone lighthouse embedded in 48 sentences in a similar manner. Both passages, in final form as used in this study, appear in Appendix I.

Table 2 shows the position of the relevant sentences in the paragraphs of each passage. It also shows the total number of words in each passage and the number of words in each paragraph.

Each passage contained 12 paragraphs of five sentences each. The material was arranged so that three paragraphs appeared on each of the four pages. In a few places the accuracy of the facts was sacrificed for

TABLE 2

CHARACTERISTICS OF PASSAGES

Passage	Paragraph number	Position of relevant sentences in paragraph	Number of words
Piccard	1	1	93
	2		82
	3	2,3	80
	4	5	87
	5		84
	6	2,3	93
	7		87
	8	1	94
	9	5	89
	10		99
	11	4,5	90
	12	1,2	85
Total			1063
Eddystone	1	1	88
	2		86
	3	5	88
	4	3,4	82
	5	2,3	85
	6		84
	7	5	83
	8		84
	9	1,2	90
	10		87
	11	1	87
	12	4,5	86
Total			1030

simplicity. While the material was controlled by sentence position, number of words and syllables, and paragraph length, the selections did appear to be fairly typical social-studies-like prose.

The prose selections were designed to be used for two different purposes--as reading passages for the two direction groups and as text material for the Focus Ability test.

Directions. The first page of the passage contained the directions. The specific directions group was instructed to read the passage once carefully and to learn the relevant facts. The general directions group was instructed to read the passage once carefully and to learn all that they could. Both groups were told to expect a posttest. The directions appear in Appendix I.

Posttests. The reading comprehension of the specific and general directions groups was measured by an immediate posttest. Each passage, Piccard and Eddystone, had a test. The tests contained fill-in-the-blank questions which could be answered with a word or number or in some cases with two or three words. The students were told that spelling did not count.

The questions in the posttests were arranged in chronological order as they appeared in the selections except in one case on each posttest. It was necessary

to exchange two questions so that each test had the same number of relevant questions in the odd and even split. There were 12 relevant and 20 incidental items in the tests. The posttests are included in Appendix I.

Focus Ability test. The focus ability or the ability to recognize relevant material and to disregard incidental material was measured by this test. The students were directed to read the passage and to find and underline the sentences which told about the relevant subject, Piccard or the Eddystone lighthouse.

The format of the Focus Ability test was identical to the specific and general direction passages--directions on the first sheet and four pages of written material. A short practice exercise was provided (see Appendix I).

Gates-McGinitie Reading Tests

The reading achievement of the students was measured by the Comprehension subtest of the Gates-MacGinitie Reading Tests, Survey D, Form 1.

It is a Cloze-type test with 21 passages containing 52 blanks to be filled from five alternative answers. According to the Technical Manual, this form has a split-half reliability of .95 and an alternative form reliability of .87 at the sixth-grade level. The correlation between the Lorge-Thorndike Intelligence tests, verbal

scores, and the Comprehension subtest at the sixth-grade level is .72 (see Appendix IV).

The manual states that the subtest measures the students' ability to read complete prose passages with understanding. The test was chosen because it was felt that the measure might have particular validity in the study. The ability to understand a prose passage might be a significant predictor of the ability to identify relevant material in a passage.

Test Administration

The investigator did all the testing. The students were told that the study was a series of reading tests.

The specific and general direction reading tests were administered first. The investigator read the directions aloud while the students read them silently. The last statement in the directions was emphasized. For example, "Learn as much as you can about Auguste Piccard."

The students were directed to read the material through one time, carefully, at their own rate. The investigator monitored this reading. Most were finished reading the passages in about 10 minutes and all the students were finished in about 14 minutes.

As soon as a student finished the single reading of the passage, a posttest was given to him and the

passage was collected.

When all the students had completed the posttest, the Focus Ability test was administered. Again, the directions were read aloud as the students read them silently. Each student completed the sample task and the investigator asked a student to read the correctly underlined sentences aloud. This test required approximately the same length of time as the reading phase of the comprehension tests.

The students were given a short break and the Gates-MacGinitie Comprehension subtest was administered. The total process required 90 minutes.

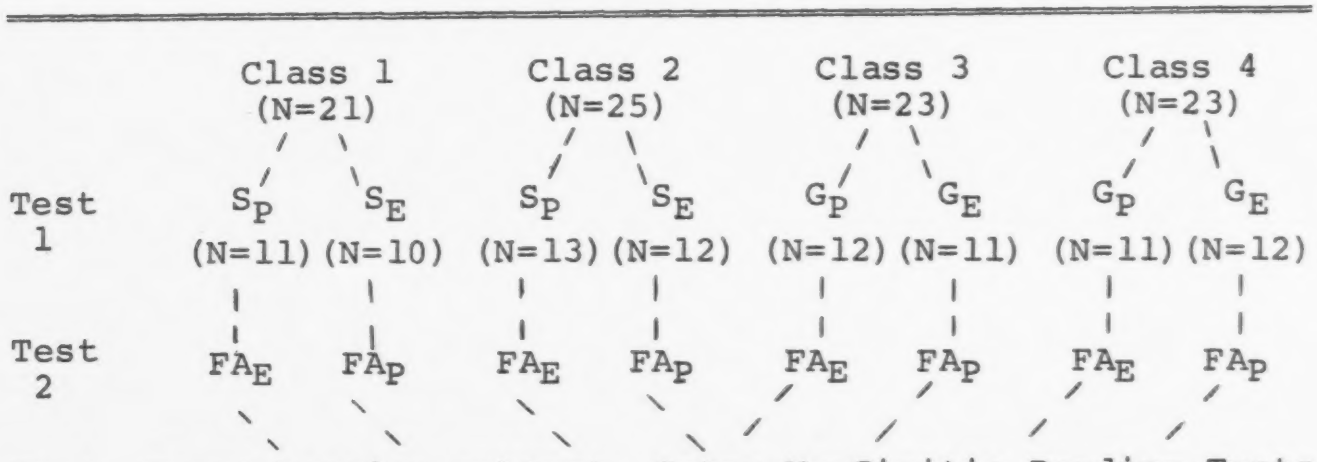
Design of the Study

The design of the study appears in Table 3. A stratified randomization procedure was used. This method of randomization was necessary because of the restrictions placed upon the experiment by the school. The four sixth-grade classes were randomly assigned to either the specific or general directions group. The students in each class were randomized, odd and even, into two material sections, Piccard or Eddystone.

All students in the Piccard material sections in the specific directions group were added together to make a single Piccard-Specific group. The same procedure was used to form the Eddystone-Specific group, the

TABLE 3

DESIGN OF THE STUDY



Piccard-General and the Eddystone-General sections. The sections maintained these identities through the experiment.

Test 1 is the appropriate posttest administered after reading the assigned passage. In Test 2, the Focus Ability test, all the students who read the Piccard passage in Test 1 switched to the Eddystone passage and vice versa. All the students in the Piccard material sections were added together to form one group and all the Eddystone students formed a second group. Test 3, the Comprehension subtest of the Gates-MacGinitie Reading tests, was administered to all of the students.

Treatment of the Data

The dependent variables in this study were as follows:

1. Number of relevant answers correct on each posttest.

2. Number of incidental answers correct on each posttest.

3. Total number of correct answers on each posttest.

4. Number of odd-numbered items correct on each posttest.

5. Number of even-numbered items correct on each posttest.

6. Number of sentences underlined correctly in the Focus Ability test.

7. Number of sentences underlined incorrectly in the Focus Ability test.

8. Gates-MacGinitie Comprehension subtest raw score.

Scores were prepared for the Focus Ability test. The score is equal to the number of sentences underlined correctly less one-fourth the number underlined incorrectly to correct for guessing.

The Gates-MacGinitie Comprehension subtest standard scores were derived from the raw scores and a table in the test manual. The use of the standard scores was recommended by the manual.

Means and standard deviations of the dependent variables were prepared for both material sections in the specific and general direction groups (see Appendix III). This appendix also includes a summary of the raw data and a description of the methods used to treat the data.

The means and standard deviations of the Gates standard scores for each material section in both direction groups were computed. A t test was done to determine if there was a significant difference between the highest and lowest mean standard scores.

The mean and standard deviation of the Gates standard scores for the five sixth-grade classes in the school, the four in the experiment, and the one in the first tryout were computed. The standard error of the test was also prepared.

Correlation coefficients were determined between the following:

1. Number of correct answers in the odd and even halves of the Piccard and Eddystone posttests.

2. Number of correct relevant answers and the Focus Ability scores in both material sections of the specific and general direction groups.

3. Focus Ability scores of the Piccard and Eddystone materials and the total number of correct answers on the posttests.

4. Focus Ability scores of the Piccard and the Eddystone materials and the Gates standard scores.

5. Gates standard scores and the total number of correct answers on the posttests of each material section of both groups.

Summary

This chapter described the sample and the informal test materials. These materials were used to study the effects of specific and general directions and the ability to identify relevant sentences in a selection. The

Comprehension subtest of the Gates-MacGinitie Reading Tests which were used to measure reading achievement was described. Details of the test administration, the design of the experiment, and the plan for treating the data were also included.

CHAPTER IV

FINDINGS AND DISCUSSION

This chapter contains a description of the results of the study on the effects of specific directions on reading comprehension of sixth-grade students. The results are presented in three sections: first, description of the test results; second, comparisons of the specific and general direction groups; and third, correlations of the variables under study.

The two questions posed in Chapter I are discussed in two sections: one on the effect of the directions and the other on the relationships between the test results.

Description of the Test Results

Posttests. Table 4 presents the mean number of questions answered correctly for the Piccard and the Eddystone sections, for the group with specific instructions, and for the group with general instructions. The table shows the mean correct answers to 12 relevant questions, to 20 incidental questions, the total correct answers, and the number of tests from which the means were calculated.

TABLE 4

MEAN NUMBER OF CORRECT ANSWERS ON THE POSTTESTS

	Specific directions			General directions		
	Mean correct answers			Mean correct answers		
Material	Relevant (12 items)	Incidental (20 items)	Total (32 items)	Relevant (12 items)	Incidental (20 items)	Total (32 items)
		N=24			N=23	
Piccard	5.4	10.4	15.8	3.7	8.4	12.1
		N=22			N=23	
Eddystone	4.9	6.4	11.3	6.5	10.0	16.5

Most pertinent are the answers to the relevant questions. With Piccard material the mean of correct answers was 5.4 with specific directions and 3.7 with general directions. With Eddystone material the mean of correct answers was 4.9 with specific directions and 6.5 with general directions.

Focus Ability test. Table 5 presents the Focus Ability scores and the number of sentences underlined correctly and incorrectly for the Piccard and Eddystone sections. The totals for each material are also shown. Scores were calculated by subtracting one-fourth of the number of sentences underlined incorrectly from the number underlined correctly. The maximum number of sentences which could be underlined correctly was 12; the maximum which could be underlined incorrectly was 48.

The Piccard section scores were 8.4 and 7.4 for the specific directions and general directions sections, respectively, with a constant standard deviation of 2.1. The Eddystone section scores were 7.2 and 9.2 for the specific and general direction sections, respectively, with standard deviations of 2.7 and 2.5.

Gates-MacGinitie test. Table 6 shows the mean standard score which each of the four sections attained on the Gates-MacGinitie Reading Tests, Survey D, Form 1, Comprehension subtest. The table shows the standard

TABLE 5

FOCUS ABILITY SCORES AND MEAN NUMBER OF SENTENCES UNDERLINED CORRECTLY AND INCORRECTLY

Sections	N	Focus Ability scores[a] $\bar{x}$	Focus Ability scores[a] s.d.	Sentences underlined: Correctly $\bar{x}$ (maximum = 12)	Sentences underlined: Incorrectly $\bar{x}$ (maximum = 48)
Piccard					
Specific	24	8.4	2.1	9.0	2.4
General	23	7.4	2.1	8.1	2.6
Total	47	7.9	2.1	8.4	2.5
Eddystone					
Specific	22	7.2	2.7	7.9	2.8
General	23	9.2	2.5	9.7	2.0
Total	45	8.2	2.8	8.8	2.4

[a]Number of sentences underlined correctly less one-fourth the sentences underlined incorrectly. Maximum score = 12.

TABLE 6

MEAN STANDARD SCORES OF THE COMPREHENSION SUBTEST OF THE GATES-MACGINITIE READING TESTS FOR ALL SECTIONS

Section	N	Gates standard scores $\bar{x}$	Gates standard scores s.d.	Grade level equivalent	Number of students with scores below 50
Specific					
Piccard	24	58.5	8.2	9.5	2
Eddystone	22	54.8	9.0	7.6	6
General					
Piccard	23	56.3	11.8	8.1	4
Eddystone	23	57.6	7.0	8.8	3
Total[a]	115	57.1	8.5	8.8	-

[a]This mean was calculated from the scores of the students in the experiment and those in the first tryout.

deviation and the grade level equivalent of the mean for each section. The same information is shown for the total number of sixth-grade students in the school (115), some of whom were in the tryout. The number of students in each group who had Gates standard scores below 50 (equivalent grade scores below grade six) is also presented.

The mean standard score for the whole school was 57.1, equivalent to 8.8 grade level, with a range in mean scores from 54.8 to 58.5 in the four sections. The standard deviation of all the scores for the whole school was 8.5 and the standard error for this test in this experiment was 2.44.

Posttest reliability. The correlation coefficients between correct odd and correct even questions on the Piccard and Eddystone posttests are: Piccard, $r = .70$, and Eddystone, $r = .65$, $p < .01$.

These correlations measure the internal consistency of the tests.

Passage comparison. The mean number of sentences underlined correctly and incorrectly in the Focus Ability test for the Piccard and Eddystone sections are shown in Table 5. Although the range of individual performance was quite broad (see Appendix III), the means of relevant sentences underlined correctly and sentences underlined

incorrectly were comparable. It appears it was equally difficult to find the relevant sentences in each passage. On average, the students found about 70 percent of the relevant sentences and made mistakes on about 5 percent of the incidental sentences.

Comparison of the Specific and General Groups

The difference in the reading comprehension achievement level between the four sections is best shown by the section mean scores on the Gates-MacGinitie Reading Tests as presented on Table 6. The Gates Comprehension subtest measures the students' ability to read complete prose passages with understanding.

The t value calculated from the lowest mean, the Eddystone Specific, and the highest mean, the Piccard Specific, was 1.46. This calculation shows that there is no significant difference at the acceptable confidence level of 95 percent in the ability of the four sections to understand written material. It must be pointed out that the highest and the lowest mean standard scores fell in the Specific group (see Table 3).

Section rankings for the Gates test and several other results obtained in this study appear in Table 7. The rankings of the means are based on the data presented in Tables 4, 5, and 6. The Gates standard scores are given first in the series. There is a consistent pattern

TABLE 7

RANKINGS OF THE SECTIONS BASED ON THE MEANS OF SEVERAL MEASURES

Section	Rank of the means					
	Gates standard	Correct answers on posttests			Sentences underlined Focus Ability test	
		Relevant	Incidental	Total	Correctly	Incorrectly[a]
Specific						
Piccard	1	2	1	2	2	2
Eddystone	4	3	4	4	4	4
General						
Piccard	3	4	3	3	3	3
Eddystone	2	1	2	1	1	1

[a]The sentences underlined incorrectly are ranked with 1 = least and 4 = most to make the table consistent.

of rankings with respect to the Gates scores. The position of the Piccard-Specific and Eddystone-General sections are consistently one or two in each of the rankings. The Eddystone-Specific and Piccard-General sections are consistently three or four.

Correlations

Correlation coefficients (r) were computed to determine the relationship between the dependent variables (see Appendix III). The coefficients and their significance appear in the tables as indicated.

Focus Ability scores and the number of relevant questions answered correctly. The correlation coefficients for Piccard-Specific and Eddystone-Specific are .14 and .04, respectively. The correlations are not significant. These data are presented in Table 8 along with the coefficients for the general group.

Focus Ability scores and total number of correct answers on the posttests. The correlation coefficients for Piccard-General and Eddystone-General are $r = .51$, $p < .01$, and $r = .17$, respectively. These data and the r's for the specific direction group are shown on Table 8.

Focus Ability scores and Gates-MacGinitie comprehension subtest standard scores. The r is .34, $p < .01$, for the correlation of Focus Ability score and Gates scores for both Piccard and Eddystone.

TABLE 8

CORRELATIONS BETWEEN FOCUS ABILITY SCORES AND NUMBER OF CORRECT RELEVANT ANSWERS AND NUMBER OF TOTAL CORRECT ANSWERS

	Relevant answers correct	Total answers correct
Section	Correlation coefficient	Correlation coefficient
Specific		
Piccard	.14	.40**
Eddystone	.04	.05
General		
Piccard	.37*	.51**
Eddystone	.21	.17

*Significant, $p < .05$.

**Significant, $p < .01$.

Gates Standard scores and total number of questions answered correctly on the posttests. The r's for Gates score vs. Piccard-Specific and Piccard-General were .78 and .81, $p < .01$, respectively. The correlations for Piccard and Eddystone are presented on Table 9.

Use of Specific and General Directions

The main question presented in Chapter I was, "Which group learns more relevant material based on posttest scores: (a) students who are given specific directions about what to learn? or (b) students who are given general directions to learn as much as they can?"

The results of the posttests on the Piccard and Eddystone material were contradictory. With specific directions to learn about Piccard, the students got an average of 5.4 questions right as compared with only 3.7 when directions were general. On the Eddystone material, the students got an average of 4.9 questions correct with specific directions and 6.5 questions correct when the directions were general.

This result was not expected.

The investigator planned to discuss the results in terms of a "conceptualization" of learning from written material described by Rothkopf (1963, 1965, 1970). His approach would suggest that the directions may control the reading behavior of the students. The directions

TABLE 9

CORRELATIONS BETWEEN GATES-MACGINITIE COMPREHENSION SUBTEST STANDARD SCORES AND TOTAL CORRECT ANSWERS ON THE POSTTESTS

Sections	Correlation coefficients
Specific	
Piccard	.78**
Eddystone	.61**
General	
Piccard	.81**
Eddystone	.50**

**Significant, $p < .01$.

should cause the students to attend to the relevant material in the passage and to learn it selectively. This selective learning was expected to show in the results of the posttests.

Based on the raw means shown on Table 4, the contradictory trend (between relevant and incidental questions answered correctly on the Piccard and Eddystone material) indicates that control of reading behavior was not attained in this study.

Three questions related to the students, the test directions and passages, and the administration of the tests should be considered:

1. Were the results on the posttests affected more by the distribution of ability to learn than by the directions?

2. What were the problems related to selective learning for these sixth-grade students in this study?

3. What were some of the factors affecting performance on the posttest, and what are the alternate ways to interpret these results?

Distribution of ability. There is some evidence that the distribution of reading achievement was an important factor in the results of the posttests and the Focus Ability test.

The series of rankings were presented in Table 7.

As it was pointed out, there is a consistent pattern with respect to the Gates scores. Sections which had higher mean reading achievement levels did better on the tests than sections which had lower mean achievement levels.

Also, it was mentioned that the highest mean and the lowest mean of the Gates standard scores were in the Specific group. This suggests that the randomization procedure may not have effectively controlled all the variables that affected the results.

Problems related to selective learning. Considering the differences in the sections, the possibility of varying levels of interest in the two passages, and the age of the children, there is some reason to suggest that selective learning was asking too much.

It is possible that the students did not retain the specific objective to learn relevant material during their reading. They may have generalized the objective. Gans (1940) found significant evidence that intermediate grade students shifted from a specific to a general understanding of a reading purpose after reading five paragraphs. Torrance and Harmon (1961) also indicated that the students in their study had difficulty in maintaining a reading set.

The test document itself may have created an additional problem. The page of specific directions carried

the title of the relevant topic on it. Even though the students were told to learn specific information, the title may have led some to believe that the whole passage should be learned. If this were the case, the students would have made no discrimination between relevant and incidental information.

During the Focus Ability tests, the students, on the average, identified only 70 percent of the relevant sentences (see Table 5). Thus, the specific directions group may have missed as much as 30 percent of the required information during their reading. It follows that they could not learn selectively something which they had not identified. This would show in the results of the posttest and in the comparison of the relevant learning of the specific and general groups.

The nature of the general directions may have affected the posttest results. The investigator considered that the general directions group was a reading control group. The evidence presented by Rothkopf (1966) suggests that the directions to read carefully affects reading comprehension scores in a positive way. If the general directions did affect the control group in this way, a comparison of the total amount learned would be difficult to make.

The posttest and alternate interpretation of results. The questions in the posttest required retention of detailed information for 15 or 20 minutes of a wide variety of subject matter: (1) dates; (2) detailed description; (3) concepts and ideas; and (4) sequential happenings, such as the series of Eddystone lighthouses.

Not only did the students have to understand the material, but they had to identify, discriminate, and recall properly. Gans (1940) described similar factors in reference reading by intermediate grade students. She found that reference reading for this age group involved reading ability, selection-rejection of the material on the basis of the problem posed, some type of delayed recall, and possibly other unidentified factors.

The Piccard posttest was more reliable than the Eddystone test (r = .70 and .65, $p < .01$, respectively). Further, the Piccard test was more consistent under both sets of directions (see Appendix III, page 144). There is some reason, then, to consider the Piccard data exclusively. The students in the Piccard sections answered significantly more relevant questions correctly under specific directions than under general directions ($t = 2.84$, $p < .01$).

Considering all the factors involved, it may be interesting to look at an alternate way of presenting all of the data which would adjust the results to a common basis.

The number of relevant questions answered correctly compared to the total number of correct answers, expressed as a percentage, were calculated for each group and passage. These results are:

	Piccard	Eddystone
Specific Directions	34%	43%
General Directions	30%	39%

The specific directions group in both cases learned more relevant material compared to the total amount learned than the general directions group. However, the percentage difference of 4 percent for each case is not statistically significant at the acceptable confidence level of 95 percent.

The investigator handled the mean scores from the Peeck (1970) study in a similar manner for purposes of comparison. The means of the scores on the question related material and the means of the total scores were expressed as a percent. The following are the results. Peeck's code is included for reference purposes.

Prequestion group (PNG)	53%
Extended Reading Time Control group (CER)	45%
Reading Control group (C)	43%

The prequestion group retained more question-related material when compared with the total amount learned than the extended reading time control group

and the reading control group. When the data are presented on the basis of relevant material learned as a percentage of total amount learned, Peeck's finding and the findings of this study are in the same direction.

Peeck discussed his results in terms of a "distribution of knowledge." After considering the data in this way, it might be said that the specific directions affected the balance of relevant and incidental learning.

Relationships Between the Test Results

All the correlations made with the Piccard posttest were consistently higher than those made with the Eddystone posttest. The lower internal consistency, as indicated by the reliability of the Eddystone posttest, may be a factor in this difference.

Focus Ability scores and the number of correct relevant answers. There were no significant correlations between these variables in the Piccard and Eddystone sections of the specific group as shown on Table 8. The results of the general sections are not pertinent to this discussion.

Focus Ability scores are the measure of the students' ability to identify relevant material in a passage, and to disregard incidental information. The number of correct relevant answers is a measure of relevant learning. It appears that the ability to identify relevant material

in a passage and the ability to learn selectively under specific directions, as measured by posttests, are not related in this study.

The investigator made sure that the students had previous training in underlining techniques by examining the students' fifth-grade reading workbooks.

It is interesting to note that the students in the trial reading of each passage said that they looked for key words during the Focus Ability test. This information was helpful in revising the tests. It is possible that this technique was used during final testing. If so, this reading behavior would be different from the careful reading used to learn selectively.

Focus Ability scores and the total number of correct answers on the posttests. For the Piccard sections there were significant correlations between the variables (r = .40 and .51, p < .01). The magnitude of these coefficients indicates that there is a moderate relationship between the two. For the Eddystone sections there were no significant correlations.

The total number of correct answers on the posttest were measures of the reading comprehension of the experimental passages. Since the results were not conclusive, no statement concerning the relationship between the variables may be made.

Focus Ability scores and Gates standard scores. There were significant correlations between these scores for both material sections. The magnitude of the correlation coefficients (r = .34, p < .01) indicates that there is a low positive relationship between the ability to identify relevant material in a passage and the ability to read a passage with understanding.

These correlations were probably influenced by the fact that extraneous factors could easily affect the Focus Ability scores because of the small number of relevant sentences (12). Factors which have a big effect on the Focus Ability scores may have little or no effect on the Gates standard scores.

Gates standard scores and the total number of correct answers on the posttests. There were significant correlations between the variables for the sections in the specific directions group (r = .78 and .61, p < .01) and in the general group (r = .81 and .50, p < .01). The values of these coefficients indicate that there is a moderate to strong relationship between the variables.

This relationship between the informal and standardized measures of reading comprehension was predicable. The investigator was particularly interested in the correlations of the general group. The posttest results of this group were measure of reading comprehension of the

students on the experimental passages unconfounded by the specific directions.

This comparison between the informal measure of comprehension and the standardized measure is in agreement with the findings of Sochor (1958). She found, using similar procedures, that the correlation between literal comprehension of social studies material and the Gates Reading Survey was .76, $p < .05$, for the fifth-grade level.

Summary

This chapter contained the results of the study on the effects of directions on reading comprehension. The findings were discussed in terms of the two questions which were posed concerning (1) the effects of the directions, and (2) the relationship of certain variables with these effects.

CHAPTER V

SUMMARY AND CONCLUSIONS

There are three sections in this chapter: the summary, the conclusions, and the suggestions for future research.

Summary

The purpose of the investigation was to study the effects of specific directions on the reading comprehension of sixth-grade students. The underlying question was, "Can the specific directions control the reading behavior of the students so that the students learn the relevant material as directed?" Further, the experiment was designed to determine if there was any relationship between the learning of the relevant material and the ability to identify the relevant material in a selection. The relationships between a standardized measure of reading achievement, the ability to identify relevant material in a passage, and the informal measure of reading comprehension of the experimental passages were also explored.

Two 1,000-word passages written on the sixth-grade reading level were prepared by the investigator. The passages were similar in construction but were written about

two different topics--Auguste Piccard and the Eddystone lighthouse. Each passage contained 12 sentences which were relevant to the topic interspersed in 48 sentences which were not directly related or were incidental to the topic. A posttest which contained 12 questions on the relevant material and 20 questions on the incidental material was prepared for each passage.

A stratified randomization procedure was used to assign the 92 sixth-grade students to direction groups and then to material sections--Piccard or Eddystone.

Two informal tests which utilized the two experimental passages and the comprehension section of a standardized reading survey were administered to the students. In the first test, half of the students were given specific directions to read the assigned passage through one time carefully and to learn about the relevant topic. The other half of the students were given general directions to read the assigned passage one time carefully and to learn as much as they could. The students were given the posttest. The number of correct relevant answers under the two types of directions was considered to be a measure of relevant learning. The total number of correct answers on the posttest (total learning) was a measure of the reading comprehension of the experimental materials.

Second, the students were given a Focus Ability

test which measured the ability to identity relevant material and to disregard incidental material. The students were directed to read a second and different passage carefully and to underline the sentences which were relevant to the topic. The Focus Ability score for each student was the number of sentences underlined correctly less a correction factor for guessing.

Third, the students were given the Comprehension subtest of the Gates-MacGinitie Reading Tests, Survey D, Form 1.

The means and standard deviations of the number of correct relevant answers, incidental answers, and total answers were prepared for the Piccard and Eddystone tests in each direction group. The means and standard deviations of the Focus Ability scores for each section were computed. Also, the standard scores for the Gates Comprehension subtest were derived from the raw scores and a table in the test manual. Means and standard deviations of these scores were calculated for each section.

The means of the relevant questions answered correctly in the specific and general directions groups were compared for both material sections. The purpose was to determine if the students answered more relevant questions correctly under specific directions than under general directions. The Piccard section had more correct relevant

answers in the specific directions group than in the general directions group. The Eddystone group had just the opposite.

Correlation coefficients were determined between the following variables: relevant learning, total learning, Focus Ability scores, and the Gates standard scores.

Conclusions

1. The control of reading behavior, as indicated by the number of correct answers on the posttests, was not attained in this study. The Piccard sections had more correct relevant answers in the specific directions group than in the general directions group. The Eddystone sections had just the opposite.

2. The ability to identify relevant material in a passage and to disregard incidental material was measured by the Focus Ability scores. Focus Ability did not appear to be related to the ability to read and learn the relevant material selectively as indicated by the number of correct relevant answers on the posttests of the specific directions group.

3. No definite conclusion could be drawn concerning the relationship between the Focus Ability scores and the total number of correct answers on the posttests. There were significant correlations (r = .40, .51, $p < .01$) in the Piccard sections and no significant

correlations in the Eddystone sections.

4. There were significant corrections (r's = .34, $p < .01$) between the Focus Ability scores and Gates standard scores for both material sections. The magnitude of the correlation coefficients indicate that there was a low positive relationship between the two variables.

5. There were significant correlations (r = .78, .61, .81, .50, $p < .01$) between the total number of correct answers on the posttest and the Gates standard scores. The values of the coefficients indicate that there was a moderate to strong relationship between the informal measures of reading comprehension and the standardized measure of comprehension.

6. There is an alternate way to consider the data. The Piccard posttest was a more consistently reliable instrument than the Eddystone posttest (r = .70 compared with r = .65, $p < .01$, and Appendix III). If the Piccard data are considered exclusively, it is possible to conclude that the reading behavior of the students was controlled by the specific directions. The students in the Piccard sections answered significantly more relevant questions correctly under specific directions than under general directions (t = 2.84, $p < .01$).

Suggestions for Future Research

The portion of the experiment concerning the effects of the specific and general directions on reading comprehension should be replicated. Certain factors which may have affected the results could be changed. For example, the reliabilities of the informal posttests could be improved and the titles could be removed from the specific directions.

Also, it would be important to use a reading survey which measured the ability to learn from written material as a pretest. The results on the pretest could be used to make sure that the groups were matched for ability.

If the results of the replication were similar to those in this investigation, it would be interesting to use more mature students as subjects. It is possible that the selective learning is too difficult for sixth-grade students.

Research on the effects of directions on learning from written material should continue. The various factors which may interact with the directions such as organization of the material, difficulty of the material, skill, and maturity of the students should be explored fully.

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APPENDIX I

INFORMAL TEST MATERIALS

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THE STORY OF AUGUSTE PICCARD AND THE THINGS THAT HE DID

Read the story carefully. Learn all about Auguste Piccard and the things that he did.

After you have turned a page do not turn back. There are four pages.

When you finish reading close your booklet and raise your hand. Your teacher will bring you a sheet with some fill-in-the-blank questions. Most will require one word or a number. Some will require two or three words. Spelling does not count. If you do not know the answer leave the question blank. Do as many as you can, but don't worry if you don't know all the answers.

Remember, read the story carefully. Learn as much as you can about Auguste Piccard.

THE STORY OF THE EDDYSTONE LIGHTHOUSE

Read the story carefully. Learn all about the Eddystone lighthouse.

After you have turned a page do not turn back. There are four pages.

When you finish reading close your booklet and raise your hand. Your teacher will bring you a sheet with some fill-in-the-blank questions. Most will require one word or a number. Some will require two or three words. Spelling does not count. If you do not know the answer leave the question blank. Do as many as you can, but don't worry if you don't know all the answers.

Remember, read the story carefully. Learn as much as you can about the Eddystone light.

Read the story carefully. Learn as much as you can.

After you have turned a page do not turn back. There are four pages.

When you finish reading close your booklet and raise your hand. Your teacher will bring you a sheet with some fill-in-the-blank questions. Most will require one word or a number. Some will require two or three words. Spelling does not count. If you do not know the answer leave the question blank. Do as many as you can, but don't worry if you don't know all the answers.

Remember, read the story carefully. Learn as much as you can.

THE STORY OF AUGUSTE PICCARD AND THE THINGS THAT HE DID

Read the story carefully. Underline the sentences which tell you about Auguste Piccard and the things that he did.

After you have turned a page do not turn back. There are four pages in the story.

Try this short example. Which sentences tell about Auguste Piccard and what he did? Underline the whole sentence.

Balloons have interested men for many years. The first balloon flight in the United States was made by a man named Blanchard. He took off from Philadelphia and flew across the Delaware River to New Jersey.

Piccard enjoyed being in balloon races when he was a young man. He won so many races that he became very well known. While balloon racing is fun, it also can be very dangerous.

THE STORY OF THE EDDYSTONE LIGHTHOUSE

Read the story carefully. Underline the sentences which tell you about the Eddystone lighthouse.

After you have turned a page do not turn back. There are four pages in the story.

Try this short example. Which sentences tell about the Eddystone lighthouse? Underline the whole sentence.

One of the best known lighthouses in the United States is the Cape Hatteras lighthouse. It stands in a national park in North Carolina and is 112 feet tall. Most lighthouses are very tall so that they can be seen from a great distance.

The Eddystone lighthouse stands 92 feet and has a red roof. This lighthouse has 203 steps up the light. Some people become very tired when they climb many steps.

Auguste Piccard was called "the man who went both ways" because he made balloons that went high into the air and deep into the sea. Years before Piccard lived, two French brothers named Montgolfier made the first balloon from an old skirt. They hung it over a fire which made plenty of smoke and filled it with hot air. It rose and went a mile before the air in the balloon cooled and it came down. Everyone who saw the balloon flight was very excited and they told all their friends about it.

The King of France heard about the balloon and asked the brothers to make a flight from his court. They filled the balloon bag with hot air and put animals in the basket. After the animals safe trip, the brothers planned and made a balloon for a manned flight over Paris. Soon afterward, Jacques Charles made a more dependable balloon which he filled with hydrogen gas. Men continued to improve balloons so that they could be used in all kinds of ways.

Balloons often have been used to take men high into the atmosphere to do research. In order to study cosmic rays, Piccard made a record flight ten miles up in a balloon. He invented the pressurized cabin which held air for him to breathe so that he could go up safely. When three Air Force men tried to break Piccard's record their balloon bag broke. Their cabin began to drop like a stone and they all came down by parachute.

A good scientist studies the laws of nature and uses these laws to help him solve problems. If a scientist wants to go up and down in a balloon, as Piccard did, he must follow certain laws. He must go up in a craft that is lighter than air so that it will float. When he wants to come down he must make the craft heavier than air. Piccard was a great scientist from Switzerland who understood the laws about balloons and used them in his inventions.

Beebe and Baron began the work on deep diving ships in 1934 before Piccard became interested. They made a record deep sea dive in an air-tight steel ball called a bathysphere. It took the mother ship about an hour to lower and raise the bathysphere on long cables. The bathysphere got its air from the mother ship because it was too small to carry air tanks. The two men saw fish that men had never seen before and Beebe wrote a book about it.

Scientists who work in the sea know that water exerts pressure or pushes against them when they are in the water. Auguste and his son Jean understood this when they built the strong deep-diving ship called the Trieste. The Piccards designed the Trieste to float up and down to the sea bottom like a balloon. At 300 feet down the pressure is ten times that at the top of the water. To do work at this pressure men need the protection of a deep diving ship that can carry them up and down.

One of the things which scientists like Beebe or Barton study in the ocean is the fish and their food chain. The food chain or food cycle starts with tiny free-floating plants and animals called plankton. The plankton drift with the currents and are eaten by small fish that live near the top of the sea. These fish are eaten in turn by larger fish which live deeper in the sea. The cycle is completed by bacteria which break down dead fish into food for the plankton.

"The man who went both ways" took the Trieste down seven miles to the lowest spot in the ocean and came up safely. This low spot is in the Pacific Ocean and is called the Challenger Deep. Men used sonar, the echo sounder, and a computer to find the spot and also to map the whole Pacific. These men found that the sea floor is like land and has mountains, plains, and deep valleys. Deep diving ships built like the Trieste can be used to go down and learn more details about the bottom.

Jacques Cousteau who was a great friend of Piccard was also a pioneer in deep-sea diving. Cousteau developed scuba which stands for "self-contained underwater breathing apparatus" and may be used in water less than 300 feet deep. Scuba lets the diver breathe air from tanks on his back through a long tube in his mouth. The diver or frogman can swim freely in the water and can study the fish and rocks. Piccard and his Trieste, and Cousteau and his scuba laid the groundwork for modern ocean research.

Scott Carpenter, the astronaut, is a man who went up into space and down into the sea just as Piccard did. Carpenter was one of the first frogmen to live deep in the sea for a month. He was part of a team of men who lived in the Sealab 200 feet under the sea. The men ate their meals and slept inside the Sealab and used scuba when they went out in the water to work. The team studied the ocean and learned how to live safely for days at a time in the deep, dark, cold water.

The Aluminaut, a deep diving ship, used a different idea than Piccard's Trieste to go up and down. It had a propeller on the top which made it work something like a helicopter. The Aluminaut had room for 3 men, and it could dive three miles into the sea. Since Piccard wanted to study places that were deep in the sea he put many scientific instruments in the Trieste. During the trips in the Trieste he was able to do experiments, collect samples and to take pictures of the bottom.

When the great balloon scientist from Switzerland died in 1962 his inventions were well known. Piccard's inventions and ideas have been widely used in pressurized cabins for airplanes and in the new deep diving ships. One good example is the Ben Franklin, a small sub that was designed by a student of Piccard. The Ben Franklin drifted for 1,500 miles in the waters of the Gulf Stream. The men studied the sea life which was sucked into a glass tube that ran through the sub.

The Eddystone lighthouse which stands on the Eddystone Rocks near Plymouth, England was built and rebuilt four times. Lighthouses like the Eddystone have been guiding ships and marking dangerous places for thousands of years. One of the first great lighthouses was called Pharos and stood near a port of Egypt. Pharos had a wood fire on the top of its huge white tower which could be seen for miles. It took years to build Pharos and men thought that it was one of the wonders of the world.

The Eddystone Rocks are part of an underwater reef which lies about 14 miles from Plymouth. Many ships pass the red granite rocks on their way to the safety of the harbor. The word Eddystone means the stone of reeling waters and that is a good description for the reef. Sir Francis Drake, the well known Englishman, said that the Eddystone Rocks were more dangerous than the open sea. The Captain of the Mayflower wrote about these ragged rocks which were a threat to his ship.

Henry Winstanley was an inventor and showman who built a strange house which he called "Winstanley's Wonders". Inside the house were all kinds of odd things like chairs with arms which caught the person who sat in them. Winstanley charged his guests a few cents to come into his fun house and see the wonders. He also owned some rich trading ships which crashed on the Eddystone Rocks and were lost. The first lighthouse to stand on the Eddystone Rocks was a silly wooden tower built by Winstanley.

Trinity House is a company which is in charge of all the lighthouses, buoys, and fog signals in England. When a lighthouse is needed, Trinity House sends an engineer to plan and build one. John Rudyard built the second Eddystone lighthouse of strong wood and filled the bottom with rock. This second lighthouse was plain and sturdy and it stood for 50 years before it burned down. Trinity House keeps a record of how and when each lighthouse in England was built.

John Smeaton was a good lighthouse engineer who worked hard. Smeaton built the third lighthouse of huge granite blocks which were carefully fitted together. This third Eddystone lighthouse was made so well that it stood for 125 years and people called it an engineering marvel. Smeaton's workmen like him because he gave them extra money for the time that they worked on the Eddystone Rocks. But, if a man did not work hard and do a good job, Smeaton fired him and sent him home.

Before the Eddystone lighthouse was built crooks called wreckers lived in a small town near the rocky coast. These wreckers put lights in dangerous spots at night to lure ships onto the rocks. The captains of the ships thought that the false lights were other ships in safe water and sailed toward them. When ships crashed the wreckers stole as much as they could and killed the crew. The wreckers hated all lighthouses because they kept the ships safe and ruined their crooked business.

By this time in England there were better ways to build lighthouses and the engineers were better trained. Winches and cranes were used to swing the ton-sized granite rocks into place. Tools like rock drills were used instead of hammers and pick axes to fit the rocks together. Steamships were used to transport rock to sites like the Eddystone Rocks and were used as floating workshops. The great engineer, Sir James Douglas, built the fourth Eddystone lighthouse which is still in use today.

Wood or coal fires and candles were used to throw light from the first lighthouses. Next, oil lamps were used, but these early lamps gave poor light and threw out soot and smoke. There was such an oil lamp in a lighthouse in Genoa where Columbus' uncle was the keeper. Later, Argand, a Swiss man, designed a round hollow wick which burned brightly inside a glass chimney or tube. The new Argand oil lamp was used for years before a better lamp was made.

The fourth lighthouse on the rocks near Plymouth is stronger than the third one because it has a solid granite base. This Eddystone lighthouse has a special shape to break the waves so that they do not splash the light. When the tide rises and the wind blows, the waves breaking in the ocean are a fantastic sight. The rough water is caused by strong crosswinds from the north and west and four powerful tides each day. The high waves and bad weather make the waters very dangerous for ships.

The Minots Ledge lighthouse stands on dangerous rocks in the ocean near the Boston Harbor. It had some of the same engineering problems as the Eddystone lighthouse did. The first Minots Ledge lighthouse was built in 1850 but it was not strong enough and was swept away in a storm. The Army Engineers built the second lighthouse with such great skill that the light is still is use. In a bad storm the waves sometimes wash over the Minots Ledge light, but its white light keeps flashing.

The Eddystone lighthouse flashes a white light twice every 30 seconds and may be seen for 18 miles. Sailors can tell the different lighthouses apart at night by looking at their lights. For example, a lighthouse may have a steady red light or a steady white light or it may flash like the Minots Ledge light. When a sailor sees a lighthouse he can tell which one it is by checking his Light List. These light lists tell him about the lighthouse, its position, and its name.

Electric lighthouses were in use in England for 75 years before they were in use in this country. In fact, the first electric lighthouse in the United States was the Statue of Liberty which was lit in 1886. Now most of the lighthouses in the world have electric lamps in them. Yet, it was not until 1959 that the oil lamp in the Eddystone lighthouse was replaced with an electric lamp. This new electric lamp at the lighthouse needs four keepers to take care of it.

POSTTEST

1. Auguste Piccard was called "the man who _____.
2. The Montgolfier brothers' balloon rose and went a mile before the air in the balloon _____.
3. The Montgolfier brothers put _____ in the basket when they made a flight for the King.
4. The Montgolfier brothers made a balloon for a manned flight over _____.
5. Jacques Charles made a more dependable balloon which he filled with _____.
6. Piccard made a record flight _____ miles up in a balloon in order to study cosmic rays.
7. Piccard invented the _____ so that he could go up in a balloon safely.
8. When _____ tried to break Piccard's record their balloon bag broke.
9. A good scientist studies the _____ and uses them to help him solve problems.
10. Piccard was a great scientist from the country of _____.
11. Beebe and Barton made a record deep sea dive in an air-tight _____ called a bathysphere.
12. Beebe and Barton's bathysphere got its air from _____ _____.
13. Beebe and Barton saw fish that men had never seen before and Beebe _____.
14. Auguste Piccard and his son, named _____, built the deep-diving ship called the Trieste.
15. The Piccards designed the Trieste to float up and down like _____.
16. At _____ feet down the pressure is ten times that at the top of the water.

17. The food _____ for fish starts with plankton.

18. Plankton are tiny _____.

19. Piccard took the Trieste down _____ miles to the lowest spot in the ocean and came up safely.

20. The lowest spot in the _____ Ocean is called Challenger Deep.

21. Men used _____ and a computer to find the lowest spot.

22. Jacquest Cousteau developed _____.

23. Piccard and Cousteau laid the groundwork for modern _____ _____.

24. Scott Carpenter was one of the first frogmen to live deep in the sea for _____.

25. Carpenter was part of a team of men who ate their meals and slept inside the _____.

26. Since Piccard wanted to study places that were deep in the sea he put _____ in the Trieste.

27. The Aluminaut had room for _____ men.

28. During the trips in the Trieste, Piccard was able to do experiments, collect samples and to _____

29. Piccard, the great balloon scientist , died in the year _____.

30. Piccard's inventions and ideas have been widely used in such things as _____.

31. The Ben Franklin drifted for 1,500 miles in the waters of the _____.

32. The men studied sea life which was sucked into a _____ that ran through the Ben Franklin.

POSTTEST

1. The Eddystone lighthouse stands on rocks near the city of _____.
2. The great Pharos lighthouse stood near a port of _____.
3. The great Pharos lighthouse had a _____ on the top of its stone tower which could be seen for miles.
4. The Eddystone Rocks are part of an _____ which lies about 14 miles from the harbor.
5. The Captain of the _____ wrote about the ragged Eddystone Rocks which were a threat to his ship.
6. Winstanley was an inventor who built a strange house which he called_____.
7. Winstanley had chairs in his house that _____ _____.
8. The first lighthouse to stand on the Eddystone Rocks was a _____ tower built by Winstanley.
9. Trinity House is a company which is in charge of _____.
10. When a lighthouse is needed, Trinity House sends _____ _____ to build one.
11. Rudyard built the second Eddystone lighthouse of strong wood and used rock to _____.
12. The second lighthouse built by Rudyard stood for _____ years before it burned down.
13. John Smeaton built the third Eddystone light of _____ which were fitted together.
14. The third Eddystone lighthouse was made so well that it stood for _____ years.
15. When ships crashed, crooks called wreckers _____.
16. The wreckers hated all _____.

17. By this time in England there were better ways to build lighthouses and the _____ were better trained.

18. Steamships were used to transport rock to sites like the Eddystone Rocks and were used as _____.

19. The great _____ built the fourth Eddystone lighthouse which is still in use today.

20. There was an oil lamp in a lighthouse in Genoa where _____ was the keeper.

21. Argand made a new kind of lamp that had a round hollow _____.

22. The fourth lighthouse on the Eddystone Rocks near Plymouth is stronger than the third one because it has _____.

23. The rough water on the rocks is caused by strong crosswinds and powerful _____.

24. The fourth Eddystone lighthouse has a special shape so that _____.

25. The Minots Ledge lighthouse stands on rocks near the _____ harbor.

26. The Minots Ledge lighthouse had some of the same _____ as the Eddystone lighthouse did.

27. The Eddystone light can be seen for _____ miles.

28. The _____ built the second Minots Ledge lighthouse with such great skill that it is still in use.

29. Sailors can tell the different lighthouses apart at night by _____.

30. The first electric lighthouse in the United States was _____ _____.

31. In 1959, the oil lamp at Eddystone lighthouse was replaced with _____.

32. _____ keepers are needed to take care of the Eddystone lighthouse.

APPENDIX II

DEVELOPMENT, TRYOUT, AND SAMPLES OF THE INFORMAL TEST MATERIALS

Development and Tryout of the Informal Instrument

The examiner prepared drafts of the two passages and ran informal tryouts with individual students. When the materials were polished the investigator tried out the study with one sixth-grade class. The students in the other four sixth-grade classes at the same school were the sample for the investigation. The materials used in the first tryout are included in this appendix.

The tryout provided information on the test materials, the time required, the logistics of coding the tests, and test administration.

After the tests were marked, the examiner made a record of the number of high and low performing students who answered each posttest item correctly. The results of the posttests of the two students who had not read the materials were studied.

The results of the Focus Ability test were not satisfactory. Nineteen of the 23 students in the tryout sample underlined all or nearly all of the sentences correctly. It appeared that the students skimmed the material and underlined the sentences which contained the key word, Piccard or Eddystone. This judgment was based on the observation of the examiner and on the explanations of students who were asked about their strategy.

The general approach of the study appeared to be sound but the two passages required substantial revision. It was necessary to embed the relevant sentences in the incidental material in a more subtle and smooth manner so that there would be a spread in the results of the Focus Ability test.

Three main strategies were used. First, the relevant sentences were placed in various positions in the passage as indicated on Table 1. Second, the key word Piccard or Eddystone was used as a false clue. For example, the use of the word Piccard appears in this pair of incidental sentences.

> Jacques Cousteau who was a great friend of Piccard was also a pioneer in deep-sea diving. Cousteau developed scuba which stands for "self-contained breathing apparatus" and may be used in water less than 300 feet.

A third was to use different words to describe the relevant subject as in this pair of relevant sentences.

> The fourth lighthouse on the rocks near Plymouth is stronger than the third one because it has a solid granite base. This Eddystone lighthouse has a special shape to break the waves so that they do not splash the light.

New posttests were prepared. The investigator wrote several new items and revised others on the basis on information from the first tryout. The investigator had two main objectives. The first was to prepare test items which could be answered by 30 to 70 percent of the students and which had some discriminative power. The second

was to make the relevant and incidental test items as equal in difficulty as possible.

A second tryout of the materials was planned. These materials appear in this appendix. Two sixth-grade classes in a neighboring community were used as the sample. The Focus Ability test was administered to one class and the general-direction treatment was administered to the other class. Both sets of materials were used. The investigator decided that the results from these tests would provide the maximum amount of helpful data from the brief time which was allotted for the tests.

The tests were marked and the results of the post-tests were analyzed as they were in the first tryout. The number of high and low performing students who identified each relevant sentence in the Focus Ability test was recorded, and the distribution of the results of the test was studied.

A few minor changes in the passages were required to make the relevant sentences more clear. It was also necessary to revise several posttest items to meet the investigator's objectives. The final results appeared to be satisfactory.

This appendix includes samples of the directions, passages, and posttests used in the first and second tryouts.

SAMPLES OF THE MATERIALS USED

IN THE FIRST TRYOUT

THE STORY OF AUGUSTE PICCARD AND THE THINGS THAT HE DID

Read the story carefully. Learn all about Auguste Piccard and the things that he did.

After you have turned a page do not turn back. There are four pages.

When you finish reading close your booklet and raise your hand. Your teacher will bring you a sheet with some fill-in-the-blank questions. Most will require one word or a number. Some will require two or three words. Spelling does not count. If you do not know the answer leave the question blank. Do as many as you can, but don't worry if you don't know all the answers.

Remember, read the story carefully. Learn as much as you can about Auguste Piccard.

THE STORY OF THE EDDYSTONE LIGHTHOUSE

Read the story carefully. Learn all about the Eddystone lighthouse.

After you have turned a page do not turn back. There are four pages.

When you finish reading close your booklet and raise your hand. Your teacher will bring you a sheet with some fill-in-the-blank questions. Most will require one word or a number. Some will require two or three words. Spelling does not count. If you do not know the answer leave the question blank. Do as many as you can, but don't worry if you don't know all the answers.

Remember, read the story carefully. Learn as much as you can about the Eddystone light.

Read the story carefully. Learn as much as you can.

After you have turned a page do not turn back. There are four pages.

When you finish reading close your booklet and raise your hand. Your teacher will bring you a sheet with some fill-in-the-blank questions. Most will require one word or a number. Some will require two or three words. Spelling does not count. If you do not know the answer leave the question blank. Do as many as you can, but don't worry if you don't know all the answers.

Remember, read the story carefully. Learn as much as you can.

THE STORY OF AUGUSTE PICCARD AND THE THINGS THAT HE DID

Read the story carefully. Underline the sentences which tell you about Auguste Piccard and the things that he did.

After you have turned a page do not turn back. There are four pages in the story.

Try this short example. Which sentence tells about August Piccard and what he did? Underline it.

Blanchard was the first man to go up in a balloon in America. Blanchard took off from Philadelphia and flew across the Delaware River to New Jersey. August Piccard liked to be in balloon races when he was a young man.

THE STORY OF THE EDDYSTONE LIGHTHOUSE

Read the story carefully. Underline the sentences which tell about the Eddystone light.

After you have turned a page do not turn back. There are four pages in the story.

Try this short example. Which sentence tells about the Eddystone lighthouse? Underline it.

The Cape Hatteras lighthouse stands in a national park in North Carolina. The Cape Hatteras lighthouse is painted red and white and has 265 steps up to the light. The Eddystone light has four keepers, three on duty and one on shore leave.

August Piccard made and rode in balloons that went high into the atmosphere and deep into the sea. Years before two French brothers named Montgolfier made the first balloon from an old skirt. They hung it over a fire which made plenty of smoke and filled it with hot air. It rose and went a mile before the air in the balloon cooled and it came down. The boys knew what made the balloon rise but they did not know what made it come down.

The King of France heard about the balloon and asked the brothers to make a flight from his court. They filled the balloon bag with hot air and put animals in the basket. After the animal's safe trip the brothers planned and made a balloon for a manned flight over Paris. The basket had its own fire to heat the air in the balloon and a bucket of water for the fire. Later, Jacques Charles found that hydrogen gas was better than hot air and soon all balloons used the gas.

A scientist studies the way that nature works and uses the laws of nature to help him solve problems. If he wants to float in the air with a balloon he must follow the laws and design a craft that is lighter than air. If he wants to fly in an airplane he has to use other laws. These laws help him get lift from the power of the engines and the shape of the wings. Piccard was a Swiss scientist who worked hard to create, build and test his inventions.

Piccard planned and built the first pressurized cabin so that he could go high in the air in his balloon. Piccard's cabin held air for him to breathe during his record trip ten miles up. Three Air Force men who were trying to set a balloon record had an adventure when their balloon bag broke. The cabin began to drop like a stone and one man got stuck in the hatch. Another man pushed him free with his foot and they all came down by parachute.

In 1943, Barton and Beebe made a record deep sea dive of more than half a mile. They went in a pressurized steel ball called a bathysphere which was planned and made by Barton. It took the mother ship about an hour to lower and raise the bathysphere on long cables. The bathysphere which got its air from the mother ship was just big enough for the two men. They saw fish that men had never seen before and Beebe wrote a book about it.

Men who work in the sea know that water exerts pressure or pushes against them when they are in the water. The water presses down from the top so the pressure gets greater as the water gets deeper. At 300 feet down the pressure is ten times the pressure at the top of the water. Piccard built a deep sea balloon called a bathyscaph which could dive deep into the sea. Piccard used metal tanks filled with gasoline as "balloons" and built a strong pressurized cabin for himself.

One of the things which men study in the ocean is the fish and their food chain. The food chain or food circle starts with tiny free-floating plants and animals called plankton. The plankton drift with the currents and are eaten by small fish and fish that live near the top of the sea. These fish are eaten in turn by larger fish and by those which live deeper in the sea. Bacteria which break down dead plants and fish into food for the plankton complete the circle.

In 1948, Piccard's bathyscaph made an unmanned dive of a mile, deeper than any ship had been before. Men used to measure the ocean depth or take soundings by lowering a weight on a rope into the water. When the weight was on the bottom they could measure how much rope was out. Now men can make maps of the whole ocean floor with sonar, the echo sounder, and a computer. They have found that the sea floor is like land and has mountains, plains and deep valleys.

Captain Cousteau who is known for his work in the ocean and his T.V. show helped to invent Scuba. It lets the diver breathe air from the tanks on his back through a long tube in his mouth. An automatic device on the tanks makes sure that the diver gets the right amount of air. The diver or frogman can swim freely under the water with his own air supply. Piccard and his son Jean made a stronger deep-diving balloon or bathyscaph named the Trieste in 1953.

Scott Carpenter, the astronaut, was one of the first men to orbit the earth in a space ship. He was also one of the first frogmen to live deep in the sea for a month. Carpenter was part of a team of men who lived in the Sealab 200 feet under the sea. The men ate their meals and slept inside the Sealab so that they could stay under the water and work. They studied the ocean and learned how to live safely for days at a time in the deep dark cold water.

The first aluminum sub, the Aluminaut, is so strong that it can go down three miles into the sea. It has room for three men and things like T.V. searchlights and an arm to get samples. The Aluminaut has a propeller on the top which helps it go up and down in the water. Piccard tested the Trieste and proved that it was well designed and built when he was 70 years old. Later Piccard's Trieste went down seven miles to the lowest spot in the ocean and came up safely.

When Piccard died in 1962 his inventions were well known and people called him "the man that went both ways". Piccard's ideas have been widely used in pressurized airplanes and space ships and in the new deep-diving ships. Last year the Ben Franklin, a small sub, drifter for 1,500 miles in the waters of the Gulf Stream. Water with sea life in it was sucked into a glass tube that went through the sub. The men studied the sea life and also studied the way that sound travels in the sea.

The Eddystone lighthouse which stands on dangerous rocks near Plymouth, England was built and rebuilt through the years. Long, long ago the Pharos light, the greatest lighthouse of all, stood near a port of Egypt. The huge white stone tower rose above a courtyard on an island and was a beautiful sight. The wood fire which burned at the top day and night could be seen for miles. It took years to build Pharos and men thought that it was one of the wonders of the world.

Through the years many well known men sailed from Plymouth to explore and to fight for England. Sir Francis Drake sailed from its good harbor in the Golden Hind in search of Spanish ships and their gold. The Pilgrims sailed from the port on the Mayflower on their way to the New World in 1620. They named their new home Plymouth in honor of the city where they began their trip. The seaport and naval base at Plymouth grew large and busy as England became a world sea power.

Henry Winstanley was an inventor who built a strange home which he called "Winstanley's Wonders". The house had a large clock on one whole wall and a windmill in the yard to pump water. Inside there were all kinds of odd things like chairs with arms which caught the person who sat in them. Winstanley charged his guests a few cents to come into his fun house and see the wonders. The first Eddystone lighthouse, a silly wooden tower, was built by Winstanley and was soon blown down.

At one time, crooks called wreckers put lights in dangerous spots at night to lure ships onto the rocks. The captains of the ships thought that the false lights were other ships in safe water and sailed toward them. When the ships crashed the wreckers stole as much as they could and killed the crew. John Rudyard who planned the second Eddystone light made the bottom of iron rods filled with tons of rock. Rudyard built the top part of the lighthouse of wood and it stood for 50 years before it burned down.

John Smeaton built the third Eddystone lighthouse of huge granite blocks which were carefully fitted together. The third light was made so well that it stood for 125 years and was copied all over the world. Many brave lightkeepers and their families have tended their lights in spite of trouble. One girl named Abby took care of her sick mother and a light during a bad storm. Her father had gone ashore to buy food and supplies and could not get back for three weeks.

There are three main kinds of lighthouses which help sailors guide or navigate their ships at sea. The "making" lights are the first lighthouses which the ships see as they are making or coming toward land after a trip. The "coasting" lights are built beside the shore to help the ships find their way along the coast line. The "guiding" lights direct the ships up channels and lead them into safe harbors. Lighthouses also mark dangerous rocks and serve as landmarks for ships which are lost

Trinity House in London, England is a guild or company which was started by a king long ago. The company is in charge of the pilots who guide the ships in and out of English ports. They also build and take care of lights, beacons, buoys and fog signals. Sailors from all over the world know what the Trinity House lights mean because they all use the same set of rules. The fourth Eddystone light which is still in use today was built by James Douglas in 1882.

Wood or coal fires and candles were used to throw light from the first lighthouses. Next oil lamps were used but these early lamps gave poor light and threw out soot and smoke. There is a record of such an oil lamp in a light in Genoa where an uncle of Columbus was the keeper. Later, Argand, a Swiss man, designed a round hollow wick which burned brightly inside a glass chimney or tube. The Argand lamp was used for years before a better oil lamp was made.

The fourth light on the Eddystone Rocks is taller than the third one and it has a solid granite base. This Eddystone light has a special shape to break the waves so that they do not splash the light. One of the modern ways to build a lighthouse on a rocky bottom is to use a metal bell or caisson. After the bell is firmly in place on the rocks the water is pumped out. The empty bell is filled with cement to make a strong base and the lighthouse is built on top.

Long ago a reflector like a big shiny saucer was put in back of the light. A French man named Fresnel thought of a way to direct the light even further. He put a lens in the middle like a "bull's eye" and put rings of prisms around it. The lens focused the light into a strong beam so that it could be seen for miles. He also thought of a way to make the lens turn so that the light would seem to flash in a special pattern.

The Eddystone light flashes a white light twice every 30 seconds and may be seen for 18 miles. The Minots Ledge light which stands on rocks in the ocean near the Boston harbor flashes a white light. The first Minots Ledge light was built in 1850 but it was soon swept away in a storm. The Army Engineers built the second lighthouse with such great skill that the light is still in use. In a bad storm the waves sometimes wash over the Minots Ledge light but its automatic light keeps flashing.

The Statue of Liberty seems to have been the first electric lighthouse in the United States. After it was turned on the other lights near New York began to use electric lamps, too. It was years before all of the other lights in the U.S. could change from oil to electric lamps. In 1959, the oil lamp at Eddystone was replaced with an electric lamp run with power from three engines. The Eddystone light which has saved many lives is one of the world's great engineering jobs.

POSTTEST PICCARD

1. Auguste Piccard made and rode in balloons that went into the atmosphere and into _____.
2. The Montgolfier brothers made the first balloon from _____.
3. The _____heard about the balloon and asked the Montgolfier brothers to make a flight.
4. The Montgolfier brothers planned and made a balloon for a manned flight over _____.
5. Jacquest Charles found that _____ was better than hot air for balloons.
6. Piccard was a scientist from _____.
7. A scientist uses _____to help him solve problems.
8. Piccard planned and built the first pressurized _____ so that he could go up in his balloon.
9. Piccard went up in a balloon and set a record of _____miles.
10. Three Air Force men had an advanture when their balloon bag _____.
11. Barton and Beebe made a record deep sea dive in a _____called a bathysphere.
12. Barton and Beebe's bathysphere got its air from _____.
13. Barton and Beebe saw _____ during their trip in their bathysphere.
14. At 300 feet down the pressure is _____times the pressure at the top of the water.
15. Piccard built a deep sea _____called a bathyscaph which could dive into the sea.
16. Piccard filled the metal tanks of his bathyscaph with _____.
17. The food' _____ for fish starts with plankton.

18. Plankton are tiny _____.

19. Piccard's first bathyscaph made an unmanned dive of a mile in the year _____.

20. Now men can make maps of the ocean floor with _____ and a computer.

21. Men have found that the sea floor is like land and has _____.

22. Captain Cousteau helped to invent _____.

23. _____helped Piccard make the Trieste.

24. Scott Carpenter was one of the first frogmen to live deep in the sea for _____.

25. The men on the Sealab team lived _____feet under the water.

26. Piccard was _____years old when he tested the Trieste.

27. The Aluminaut has room for _____men.

28. The Trieste went down _____miles and came up safely.

29. People called Piccard "the man that _____".

30. Piccard's ideas have been used in _____.

31. The Ben Franklin drifted for 1,500 miles in the waters of the _____.

32. Water with sea life in it was sucked into a _____ that went through the Ben Franklin.

POSTTEST EDDYSTONE

1. The Eddystone lighthouse stands on rocks near _____.
2. The great Pharos lighthouse stood near a port of _____.
3. There was a _____which could be seen for miles at the top of the Pharos lighthouse.
4. Sir Francis Drake sailed in search of _____.
5. The _____named their new home in honor of the city in England where they began their trip.
6. Henry Winstanley called his home _____.
7. Winstanley had chairs in his house that _____ _____.
8. The first Eddystone light was a _____ tower, that was soon blown down.
9. _____put lights in dangerous spots at night to lure ships onto the rocks.
10. John Rudyard filled the bottom of the second Eddystone light with _____.
11. The second light built by Rudyard stood for 50 years before it _____.
12. John Smeaton built the third Eddystone light of _____which were fitted together.
13. The third Eddystone light stood for _____years.
14. A girl named Abby took care of her mother and _____ during the storm.
15. The _____lights are the first lighthouses which the ships see as they are coming toward land after a trip.
16. The "Guiding" light directs the ships up channels and lead them _____.
17. Trinity house in London, England was started by _____.

POSTTEST EDDYSTONE

18. Trinity House is in charge of the _____ who guide the ships in and out of English ports.
19. The fourth Eddystone light is _____ today.
20. One of the early oil lamps was in a lighthouse in Genoa where _____ was the keeper.
21. Argand made a new kind of lamp that had a round hollow_____.
22. The fourth Eddystone lighthouse is _____ than the third lighthouse.
23. A bell or caisson is filled with _____ to make a strong base for a lighthouse.
24. The fourth Eddystone lighthouse has a special _____ to break the waves.
25. Fresnel's lens focused the light in a strong beam so that it could _____.
26. Fresnel thought of a way to make his lens turn so that the light would seem to_____.
27. The Eddystone light can be seen for _____ miles.
28. The Minots Ledge light which stands near the _____ harbor flashes a white light.
29. The _____ built the second Minots Ledge light with great skill.
30. The Statue of Liberty seems to have been the first _____ in the United States.
31. In the year _____ the oil lamp at Eddystone was replaced with an electric lamp.
32. The Eddystone lighthouse is one of the world's great _____.

SAMPLES OF THE MATERIALS USED

IN THE SECOND TRYOUT

Read the story carefully. Learn as much as you can.

After you have turned a page do not turn back. There are four pages.

When you finish reading close your booklet and raise your hand. Your teacher will bring you a sheet with some fill-in-the-blank questions. Most will require one word or a number. Some will require two or three words. Spelling does not count. If you do not know the answer leave the question blank. Do as many as you can, but don't worry if you don't know all the answers.

Remember, read the story carefully. Learn as much as you can.

THE STORY OF AUGUSTE PICCARD AND THE THINGS THAT HE DID

Read the story carefully. Underline the sentences which tell you about Auguste Piccard and the things that he did.

After you have turned a page do not turn back. There are four pages in the story.

Try this short example. Which sentence tells about Auguste Piccard and what he did? Underline it.

Blanchard, who was the first man to go up in a balloon in America, took off from Philadelphia and flew to New Jersey. Balloons have interested men for many years. Auguste Piccard liked to be in balloon races when he was a young man.

THE STORY OF THE EDDYSTONE LIGHTHOUSE

Read the story carefully. Underline the sentences which tell about the Eddystone light.

After you have turned a page do not turn back. There are four pages in the story.

Try this short example. Which sentence tells about the Eddystone lighthouse? Underline it.

The Cape Hatteras lighthouse stands in a national park in North Carolina and is 112 feet tall. Most lighthouses are tall so that they may be seen from a great distance. The Eddystone lighthouse stands 92 feet tall and has a red roof.

Auguste Piccard was a great scientist who made balloons that went high into the atmosphere and deep into the sea. Years before Piccard lived, two French brothers named Montgolfier made the first balloon from an old skirt. They hung it over a fire which made plenty of smoke and filled it with hot air. It rose and went a mile before the air in the balloon cooled and it came down. Everyone who saw the balloon flight was very excited and they told all their friends about it.

The King of France heard about the balloon and asked the brothers to make a flight from his court. They filled the balloon bag with hot air and put animals in the basket. After the animals safe trip, the brothers planned and made a balloon for a manned flight over Paris. Soon afterward, Jacques Charles made a more dependable balloon which he filled with hydrogen gas. Men continued to improve balloons so that they could be used in all kinds of ways.

Piccard made a record flight ten miles up in a balloon so that he could study cosmic rays. He invented the pressurized cabin which held air for him to breathe so that he could go up safely. When three Air Force men tried to break Piccard's record their balloon bag broke. Their cabin began to drop like a stone and one man got stuck in the hatch. Another man pushed him free with his foot and they all came down by parachute.

A good scientist studies the laws of nature and uses these laws to help him solve problems. If he wants to go up and down in a balloon, as Piccard did, he must follow certain laws. He must go up in a craft that is lighter than air so that it will float. When he wants to come down he must make the craft heavier than air. Piccard was a scientist from Switzerland who understood the laws about balloons and used them in his inventions.

Beebe and Barton began the work on deep diving ships in 1934 before Piccard became interested. They made a record deep sea dive in an air-tight steel ball called a bathysphere. It took the mother ship about an hour to lower and raise the bathysphere on long cables. The bathysphere got its air from the mother ship because it was too small to carry air tanks. The two men saw fish that men had never seen before and Beebe wrote a book about it.

Scientists who work in the sea know that water exerts pressure or pushes against them when they are in the water. At 300 feet down the pressure is ten times that at the top of the water. To do work at this pressure men need the protection of a deep diving ship that can carry them up and down. Piccard and his son Jean understood this when they built the strong deep-diving ship called the Trieste. They designed the Trieste to float up and down to the sea bottom like a balloon.

One of the things which men like Beebe, Barton or Piccard study in the ocean is the fish and their food chain. The food chain or food cycle starts with tiny free-floating plants and animals called plankton. The plankton drift with the currents and are eaten by small fish that live near the top of the sea. These fish are eaten in turn by larger fish which live deeper in the sea. The cycle is completed by bacteria which break down dead fish into food for the plankton.

Piccard took the Trieste down seven miles to the lowest spot in the ocean and came up safely. This low spot is in the Pacific Ocean and is called the Challenger Deep. Men used sonar, the echo sounder, and a computer to find the spot and also to map the whole Pacific. They found that the sea floor is like land and has mountains, plains and deep valleys. Deep diving ships like the Trieste can be used to go down and learn more details about the bottom.

Jacques Cousteau who was a great friend of Piccard was also a pioneer in deep-sea diving. Cousteau developed scuba which stands for "self-contained underwater breathing apparatus" and may be used in water less than 300 feet deep. Scuba lets the diver breathe air from tanks on his back through a long tube in his mouth. The diver or frogman can swim freely in the water and can study the fish and rocks. Piccard and his Trieste, and Cousteau and his scuba laid the groundwork for modern ocean research.

Scott Carpenter, the astronaut, is a man who is interested in space and the sea just as Piccard was. Carpenter was one of the first frogmen to live deep in the sea for a month. He was part of a team of men who lived in the Sealab 200 feet under the sea. The men ate their meals and slept inside the Sealab and used scuba when they went out in the water to work. They studied the ocean and learned how to live safely for days at a time in the deep, dark, cold water.

The Aluminaut, a deep diving ship, used a different idea than Piccard's Trieste to go up and down. It had a propeller on the top which made it work something like a helicopter. The Aluminaut had room for 3 men, and it could dive three miles into the sea. Since Piccard wanted to study places that were deeper than three miles he put many scientific instruments in the Trieste. During the trips he was able to do experiments, collect samples and to take pictures of the bottom.

When Piccard died in 1962 his ideas were well known and people called him "the man that went both ways". His inventions have been widely used in pressurized cabins for airplanes and in the new deep diving ships. One good example is the Ben Franklin, a small sub that was designed by a student of Piccard. The Ben Franklin drifted for 1,500 miles in the waters of the Gulf Stream. The men studied the sea life which was sucked into a glass tube that ran through a sub.

The Eddystone lighthouse which stands on the Eddystone Rocks near Plymouth, England was built and rebuilt four times. Lighthouses like the Eddystone have been guiding ships and marking dangerous places for thousands of years. One of the first great lighthouses was called Pharos and stood near a port of Egypt. Pharos had a wood fire which could be seen for miles on the top of its huge white tower. It took years to build Pharos and men thought that it was one of the wonders of the world.

The Eddystone Rocks are part of an underwater reef which lies about 14 miles from Plymouth. Many ships pass the red granite rocks on their way to the safety of the harbor. The word Eddystone means the stone of reeling waters and that is a good description for the reef. Sir Francis Drake, the well known Englishman, said that the Eddystone Rocks were more dangerous than the open sea. The Captain of the Mayflower wrote about the great ragged stones which were a threat to his ship.

Henry Winstanley was an inventor and showman who built a strange house which he called "Winstanley's Wonders". Inside the house were all kinds of odd things like chairs with arms which caught the person who sat in them. Winstanley charged his guests a few cents to come into his fun house and see the wonders. He also owned some rich trading ships which crashed on the Eddystone Rocks and were lost. Winstanley built the first Eddystone lighthouse, a silly wooden tower, but it was soon blown down.

Trinity House in London, England is a guild or company which was started by a king long ago. The company is in charge of all the lighthouses, beacons, buoys and fog signals in the whole country. Whenever a lighthouse is needed Trinity House sends an engineer to design and build one. John Rudyard built the second Eddystone lighthouse of strong wood and filled the bottom with rock. This second light was plain and sturdy and stood for 50 years before it burned down.

John Smeaton built the third Eddystone lighthouse of huge granite blocks which were carefully fitted together. This lighthouse was made so well that it stood for 125 years and people called it an engineering marvel. The builder, John Smeaton,was a good engineer who did not care for money or fame. Smeaton's workmen liked him because he gave them extra money for the time that they worked on the Eddystone Rocks. However, if a man did not work hard and do a good job Smeaton fired him and sent him home.

Before the Eddystone light was built crooks called wreckers lived in a small town near the rocky coast. These wreckers put lights in dangerous spots at night to lure ships onto the rocks. The captains of the ships thought that the false lights were other ships in safe water and sailed toward them. When ships crashed the wreckers stole as much as they could and killed the crew. The wreckers hated all lighthouses, especially the Eddystone, because the lights kept the ships safe and ruined their crooked business.

By this time in England there were better ways to build lighthouses. Winches and cranes were used to swing the ton-sized granite rocks into place. Tools like rock drills were used instead of hammers and pick axes to fit the rocks together and the engineers were better trained. Steamships were used to transport rock to difficult sites like the Eddystone Rocks and were used as floating workshops. The great engineer, Sir James Douglas, built the fourth Eddystone lighthouse which is still in use today.

Wood or coal fires and candles were used to throw light from the first lighthouses. Next, oil lamps were used, but these early lamps gave poor light and sometimes caused fires like the one in the second Eddystone light. There was such an oil lamp in a lighthouse in Genoa where Columbus' uncle was the keeper. Later, Argand, a Swiss man, designed a round hollow wick which burned brightly inside a glass chimney or tube. The new Argand oil lamp was used for years before a better lamp was made.

The fourth light on the Eddystone Rocks is stronger than the third one because it has a solid granite base. This Eddystone light has a special shape to break the waves so that they do not splash the light. When the tide rises and the wind blows, the waves breaking in the ocean are an unbelievable sight. The rough water is caused by strong crosswinds from the north and west and four powerful tides each day. The high waves and bad weather make the waters very dangerous for ships.

The Minots Ledge light stands on rocks in the ocean near the Boston Harbor. It had some of the same engineering problems as the Eddystone light did. The first Minots Ledge light was built in 1850 but it was not strong enough and was swept away in a storm. The Army Engineers built the second lighthouse with such great skill that the light is still in use. In a bad storm the waves sometimes wash over the Minots Ledge light, but its white light keeps flashing.

The Eddystone light flashes a white light twice every 30 seconds and may be seen for 18 miles. Sailors can tell the different lighthouses apart at night by looking at their lights. For example, a lighthouse may have a steady red light or a steady white light or it may flash like the Eddystone light or the Minots Ledge light. When a sailor sees a lighthouse he can tell which one it is by checking his Light List or charts. These lists tell him about the lighthouse, its position and its name.

Electricity was used for lighthouses in England 75 years before it was used in the United States. In fact, the first electric lighthouse in this country was the Statue of Liberty which was lit in 1886. Now most of the lighthouses in the world have electric lamps and some are automatic and do not need keepers. Yet, it was not until 1959 that the oil lamp at the Eddystone lighthouse was replaced with an electric one. The new electric lamp is run by power from three deisel engines and four keepers are needed to take care of the lighthouse.

POSTTEST

1. Auguste Piccard was a great scientist who made balloons that went _____ and deep into the sea.
2. The Montgolfier brothers' balloon rose and went a mile before the air in the balloon _____.
3. The King of France heard about this balloon and asked the brothers to _____.
4. The Montgolfier brothers planned and made a balloon for a manned flight over _____.
5. Jacques Charles made a more dependable balloon which he filled with _____.
6. Piccard made a record flight _____ miles up in a balloon.
7. Piccard invented the pressurized _____so he could go up safely.
8. When three Air Force men tried to break Piccard's record their _____ broke.
9. A good scientist studies the _____ and uses them to help him solve problems.
10. Piccard was a scientist from _____.
11. Beebe and Barton made a record deep sea dive in a _____ called a bathysphere.
12. Beebe and Barton's bathysphere got its air from _____.
13. Beebe and Barton saw fish that men had never seen before and Beebe _____.
14. At _____ feet down the pressure is ten times that at the top of the water.
15. Piccard and _____ built the deep-diving ship called the Trieste.
16. They designed the Trieste to float up and down like a _____.
17. The food _____ for fish starts with plankton.

18. Plankton are tiny _ _____.

19. Piccard took the Trieste down _____ miles and came up safely.

20. The lowest spot in the sea is in the Pacific Ocean and is called _____.

21. Men used _____ and a computer to find the lowest spot.

22. Jacques Cousteau developed _____.

23. Piccard and Cousteau laid the groundwork for _____.

24. Scott Carpenter was one of the first frogmen to live deep in the sea for _____.

25. Carpenter was part of a team of men who ate their meals and slept inside the _____.

26. Piccard put many _____ in the Trieste.

27. The Aluminaut has room for _____ men.

28. During the trips he was able to do experiments, collect samples and to _____.

29. People called Piccard "the man that _____".

30. Piccard's inventions have been used in _____.

31. The Ben Franklin drifted for 1,500 miles in the waters of the _____.

32. The men studied sea life which was sucked into a _____ that ran through the Ben Franklin.

POSTTEST

1. The Eddystone lighthouse stands on rocks near the city of _____.
2. The great Pharos lighthouse stood near a port of _____.
3. Pharos had a _____ which could be seen for miles on the top of its stone tower.
4. The word Eddystone means _____.
5. _____, the well known Englishman, said that the Eddystone rocks were more dangerous than the open sea.
6. Henry Winstanley called his home _____.
7. Winstanley had chairs in his house that _____ _____.
8. The first Eddystone light was a _____ tower, that was soon blown down.
9. Trinity House in London, England is in charge of _____.
10. When a lighthouse is needed, Trinity House sends an _____ to build one.
11. Rudyard built the second Eddystone light of strong wood and filled the bottom with _____.
12. The second light built by Rudyard stood for 50 years before it _____.
13. John Smeaton built the third Eddystone light of _____ which were fitted together.
14. The third Eddystone light stood for _____ years.
15. When ships crashed crooks called wreckers _____.
16. The wreckers hated all _____ because they ruined their business.
17. By this time in England there were better ways to build lighthouses and the _____ were better trained.
18. Steamships could be used to transport rock and as _____.

19. _____ built the fourth Eddystone lighthouse which is still in use today.

20. One of the early oil lamps was in a lighthouse in Genoa where _____ was the keeper.

21. Argand made a new kind of lamp that had a round hollow _____.

22. The fourth Eddystone lighthouses is _____ than the third lighthouse because it has a solid base.

23. The rough water on the rocks are caused by strong crosswinds and powerful _____.

24. The fourth Eddystone lighthouse has a special shape so that _____.

25. The Minots Ledge light stands on rocks near the _____ harbor.

26. The Minots Ledge light had the same _____ as the Eddystone light.

27. The Eddystone light can be seen for _____ miles

28. The Army Engineers built the second Minots Ledge light with such great skill that it _____.

29. Sailors can tell the different lighthouses apart at night by _____.

30. The first electric lighthouse in the United States was _____ _____.

31. In 1959 the oil lamp at Eddystone light was _____.

32. _____ keepers are needed to take care of the Eddystone lighthouse.

APPENDIX III

SUMMARY OF THE DATA

Method of Calculation

Summaries of the raw data, the results of the statistical treatment, and an example of one page of the computer printout are included in this appendix.

The data were processed by computer programs designed to make statistical calculations using the General Electric Time Sharing Service. The programs were prepared by Mr. Robert Jacobson, Chief Engineer, Agricultural Division, American Cyanamid Company, Princeton, New Jersey. The correlation procedures used in the program were described by Dixon and Massey (1957). The significance of the correlations were derived from Table A-30a, p. 468, Dixon and Massey (1957).

Certain other calculations which were required were done by the investigator. The Pearson-Product Moment Correlation procedures were used in this case.

The formulas used in the $\underline{t}$ test were as follows:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{sp\sqrt{\frac{1}{N_1} + \frac{1}{N_2}}} \qquad sp^2 = \frac{(N_1-1)s_1^2 + (N_2-1)s_2^2}{N_1 + N_2 - 2}$$

The formula used to calculate standard deviations was as follows:

$$s.d. = \sqrt{\frac{\Sigma d^2 - (\Sigma d)^2/N}{N - 1}}$$

The following formula was used to determine the standard error of the Gates-MacGinitie Reading Tests in the experiment.

$$s_e = s_x \sqrt{1 - r_x}$$

RAW DATA RANKED ACCORDING TO GATES-MACGINITIE
COMPREHENSION STANDARD SCORES
PICCARD-SPECIFIC
N = 24

Gates standard scores	Correct answers			Sentences underlined	
	Relevant	Incidental	Total	Correctly	Incorrectly
73	7	12	19	4	0
68	7	13	20	9	0
68	9	16	25	11	1
68	7	16	23	12	0
66	5	13	18	11	2
66	7	15	22	10	2
63	7	17	24	9	1
63	4	8	12	11	2
63	8	13	21	7	1
61	7	9	16	9	0
61	8	6	14	7	0
61	8	11	19	11	2
59	3	12	15	9	4
56	6	6	12	7	7
55	6	11	17	10	2
55	4	6	10	6	3
55	4	13	17	12	4
54	4	11	15	7	2
54	2	7	9	10	7
52	3	9	12	10	0
51	5	7	12	9	2
50	3	9	12	7	0
44	2	3	5	10	12
38	4	6	10	7	3

RAW DATA RANKED ACCORDING TO GATES-MACGINITIE
COMPREHENSION STANDARD SCORES
PICCARD-GENERAL
N = 23

Gates standard scores	Correct answers			Sentences underlined	
	Relevant	Incidental	Total	Correctly	Incorrectly
73	5	13	18	12	5
73	8	16	24	12	0
68	4	11	15	6	0
66	3	9	12	6	0
66	7	13	20	7	0
66	4	9	13	10	1
63	4	5	9	8	2
63	5	12	17	3	1
63	3	7	10	6	0
61	5	10	15	8	0
59	5	11	16	9	0
58	5	12	17	10	5
55	4	11	15	10	0
55	1	12	13	8	2
55	3	5	8	9	7
54	4	3	7	5	2
54	4	8	12	8	4
51	4	8	12	8	1
50	2	7	9	7	0
46	5	10	15	8	3
34	0	0	0	7	8
33	1	1	1	8	9
30	0	1	1	9	9

RAW DATA RANKED ACCORDING TO GATES-MACGINITIE
COMPREHENSION STANDARD SCORES
EDDYSTONE-SPECIFIC
N = 22

Gates standard scores	Correct answers			Sentences underlined	
	Relevant	Incidental	Total	Correctly	Incorrectly
73	11	14	25	9	3
68	6	10	16	10	3
66	8	16	24	1	0
61	3	11	14	9	7
61	2	6	8	10	2
59	8	10	18	10	3
59	4	6	10	10	6
58	3	2	5	9	1
58	10	7	17	8	0
56	5	5	10	11	4
56	3	5	8	6	1
55	7	7	14	12	0
55	7	15	22	9	0
54	2	5	7	9	2
54	3	4	7	7	5
54	2	2	4	5	3
49	1	1	2	9	0
48	3	1	4	8	4
44	5	6	11	4	0
40	4	5	9	7	2
39	6	2	8	6	8
38	4	2	6	5	8

RAW DATA RANKED ACCORDING TO GATES-MACGINITIE
COMPREHENSION STANDARD SCORES
EDDYSTONE-GENERAL
N = 23

Gates standard scores	Correct answers			Sentences underlined	
	Relevant	Incidental	Total	Correctly	Incorrectly
73	10	12	22	12	0
68	4	16	20	12	2
68	7	9	16	12	4
66	9	11	20	12	3
63	8	11	19	12	0
63	8	13	21	12	0
59	4	8	12	4	2
59	7	12	19	10	4
59	6	14	20	9	1
58	5	9	14	7	0
58	7	8	15	11	0
58	7	6	13	11	4
56	6	12	18	8	0
56	7	11	18	7	1
55	3	9	12	12	0
55	5	8	13	8	6
54	5	14	19	10	1
54	3	5	8	11	8
51	6	12	18	9	0
50	7	6	13	5	4
49	8	6	14	11	0
48	7	9	16	9	4
44	7	10	17	8	1

SUMMARY OF THE MEANS AND STANDARD DEVIATIONS OF SPECIFIC AND GENERAL DIRECTIONS GROUPS

Variables	Piccard				Eddystone			
	Specific		General		Specific		General	
	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.	$\bar{x}$	s.d.
Correct answers								
Relevant	5.42	2.08	3.74	1.98	4.86	2.71	6.52	1.76
Incidental	10.40	3.77	8.44	4.27	6.46	4.48	10.04	2.90
Total	15.82	5.20	12.18	5.94	11.32	6.61	16.56	3.82
Odd	8.00	2.80	6.04	3.36	6.73	3.27	8.96	2.18
Even	7.79	2.87	6.13	3.01	4.59	3.65	7.61	2.27
Sentences underlined								
Correctly	8.96	2.05	8.09	2.13	7.91	2.58	9.65	2.37
Incorrectly	2.38	2.86	2.57	3.12	2.82	2.63	1.96	2.27
Gates scores								
Raw	45.3	6.28	42.5	11.1	42.3	7.84	45.1	4.52
Standard	58.5	8.23	56.3	11.8	54.8	9.04	57.6	7.03
Focus ability score	8.41	2.14	7.45	2.12	7.21	2.66	9.1630	2.47

SUMMARY OF THE CORRELATION COEFFICIENTS

Variables correlated	Correlation coefficients			
	Piccard		Eddystone	
	Specific	General	Specific	General
Odd vs. even	.68**	.74**	.83**	.47*
Relevant vs. Focus Ability scores	.14	.37*	.05	.21
Incidental vs. Focus Ability scores	.48*	.54**	.05	.10
Total answers correct vs. Gates standard scores	.78**	.81**	.61**	.50**
Relevant vs. incidental answers correct	.54**	.77**	.67**	.31
Total answers correct vs. Focus Ability scores	.40*	.51**	.06	.17
Focus Ability scores vs. Gates standard scores		.34**		.34**

*Significance, $p < .05$.

**Significance, $p < .01$.

SAMPLE PRINTOUT

9 -- * EDDYSTØNE SPECIFIC RELEVANT * *

UNBIASED ESTIMATE ØF PØPULATIØN PARAMETERS

ARITHMETIC MEAN=	4.864
STD.DEVIATIØN=	2.713
CØEFF.ØF VARIABILITY(PCT)	55.785
NUMBER ØF SAMPLES=	22.000
HIGHEST PØINT=	11.000
LØWEST PØINT=	1.000
RANGE=	10.000

DISTRIBUTIØN ØF PØPULATIØN SAMPLES

SIGMAS BELØW					MEAN				SIGMAS ABØVE	
3.0	2.0	1.5	1.0	0.5	M	0.5	1.0	1.5	2.0	3.0
0	0	1	3	5	3	2	2	5	0	1	0

9.52991 13.1667

10 -- * EDDYSTØNE SPECIFIC INCIDENTAL * *

UNBIASED ESTIMATE ØF PØPULATIØN PARAMETERS

ARITHMETIC MEAN=	6.455
STD.DEVIATIØN=	4.480
CØEFF.ØF VARIABILITY(PCT)	69.406
NUMBER ØF SAMPLES=	22.000
HIGHEST PØINT=	16.000
LØWEST PØINT=	1.000
RANGE=	15.000

DISTRIBUTIØN ØF PØPULATIØN SAMPLES

SIGMAS BELØW					MEAN				SIGMAS ABØVE	
3.0	2.0	1.5	1.0	0.5	M	0.5	1.0	1.5	2.0	3.0
0	0	0	2	5	7	3	3	0	1	1	0

9.53014 14